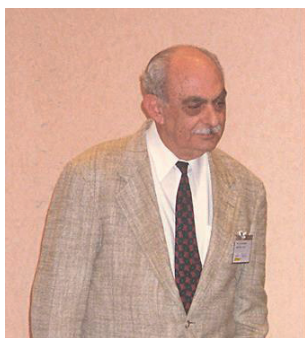


L.B. MAGALAS*[#]**ANDREW GRANATO: A MEMORIAL TRIBUTE**

The following is the text in memory of the late Andy Granato, professor in physics and materials science.

Keywords: dislocation string model, Granato-Lücke model, interstitial theory of condensed matter, ultrasonic attenuation, internal friction, mechanical spectroscopy,

1. Andrew Vincent Granato

Born in Cleveland, Ohio, USA, in 1926, and died on Wednesday June 3, 2015, Urbana, Illinois, USA. He graduated from Bethlemlen Central High School in Delmar, New York. He received BS (1948) and MS (1950) degrees from the Rensselaer Polytechnic Institute (Troy, New York) and a Ph.D. in 1955 from Brown University (Providence, Rhode Island). He was a Research Associate at Brown from 1955-57. From 1957-59 he was a Research Assistant Professor at the University of Illinois. From 1959-61 he was a visiting Professor in Aachen, Germany, holding a Guggenheim Fellowship his first year. He was appointed Associate Professor for Physics in 1961 and Professor of Physics in 1964. During 1971-72 he was an Associate in the Center for Advanced Study at the University of Illinois. In 1976, he received a U.S. Scientist Award from the Alexander von Humboldt Foundation for Research at the Technical University in Aachen. He was a member of the Executive Committee of the Division of Condensed Matter Physics of the American Physical Society, a Fellow of the American Physical Society and the Acoustical Society of America, and a member of the American Institute of Metallurgical Engineers, and the Institute of Electrical and Electronics Engineers. He was chairman of the International Conference on Internal Friction and Ultrasonic Attenuation held in Urbana, Illinois

(1985). In 1987-88, he was the Bernd T. Matthias Visiting Scholar at the Los Alamos National Laboratory and Guest Research Fellow at the Institute for Industrial Science at the University of Tokyo.

For half a century, Andrew was a world-renowned physicist at the University of Illinois, publishing more than 170 peer-reviewed papers and the primary sponsor of 32 Ph.D students. His research included such topics as crystalline materials (dislocations), impurity and interstitial atoms, and behavior of glassy materials and the glass transition (regarded as one of the most important problems still to be fully resolved in Condensed Matter Physics). He also received several fellowships and awards (including the Zener Prize as well as the Guggenheim and Humboldt fellowships) for his work. Andrew's life's work was about the importance of research and supporting the researchers who are the future of science and innovation.

2. Andrew Granato (1926 - 2015) in memoriam

In 2015 the community of Dislocations, Internal Friction and Ultrasonic Attenuation in Solids lost an eminent researcher with the death of Professor Andrew Granato. Throughout his professional life Professor Granato acquired the unrivalled reputation in our community for his outstanding contribution to the understanding of dislocation dynamics. For his scientific achievements he was awarded many important prizes and awards, among others the Clarence Zener Prize bestowed on him in 1996 for his fundamental work on dislocations.

Professor Granato had many friends round the world with whom he established and maintained close professional relationships, incessantly providing invaluable scientific inspiration and mentorship. I had a privilege to be one of them for the last 30 years.

One of my first encounters with Andy took place in Kraków, Poland, in 1990 at the First International School

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on Mechanical Spectroscopy, MS-1. Therein Andy strongly encouraged me to put forward the notion of Mechanical Spectroscopy. Later, I also received strong support and encouragement from Art Nowick, for which I am deeply grateful to both of them.



Andy Granato during the Clarence Zener Medal Ceremony on July 10, 1996 in Poitiers, France

From numerous encounters with Andy I remember especially well the one in Yasnaya Polyana, where we visited Leo Tolstoy's grave during the International Conference on Imperfections Interaction and Anelasticity Phenomena in Solids in Tula, Russia (1997). As we strolled leisurely through the Forest of the Old Order, Andy invited me to talk, surprisingly requesting me to explain to him a concept of coupled (non-Debye) relaxations in solids. The discussion was marked with frequent moments of silence, which I recall so very well, as if both of us simultaneously needed time for quick analysis of the discussed problems. I felt honoured to be involved in such an exciting and long discussion when Andy surprised me again offering me his ideas on the shear modulus of liquids as well as on the theory he then worked on, currently known as the interstitialcy theory of condensed matter. On another occasion we analyzed the question of accuracy with which subtle changes in the modulus at kHz and Hz frequencies and in the shear modulus near phase transitions and the glass temperature can be measured. I also recall how surprisingly Andy concluded another discussion. Then he expressed his concern about the accuracy of amplitude-dependent internal friction measurements. Interestingly, this problem remains unresolved to date and effectively, requires interdisciplinary research.

What was peculiar about Andy is that when talking to him difficult problems seemed simple, but only later did they appear complex and challenging. And also, that his knowledge and authority were always matched by his warm and caring nature, generously guiding others with his inspiration.



Andy Granato during the First International School on Mechanical Spectroscopy MS – 1, September 9, 1991 in Kraków, Poland

I am certain that many colleagues round the world owe Andy equally fascinating experiences, possible only in encounters with a respected authority of this rank, experiences vital in opening new horizons in the scientific development.

Andy was a kind generous friend to many and will be greatly missed.

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Andy and I met by accident at a meeting of the American Physical Society (Baltimore, 1954 or '55). We were sitting next to each other and found that our thesis topics were on the same subject, non-linear dislocation damping, his theoretical and mine experimental. I asked him what he had found for the curve, and he wrote down the now famous Granato-Lücke formula, although without the pre-exponential factor of $(1/\epsilon)$. I said yes, and showed him a slide of data exhibiting that law, data taken in Urbana. While I was slow publishing, Andy and Kurt Lücke derived considerable comfort from knowing that they were on solid ground, as did I. I savored our long talks at the international conferences as late as Bilbao (2002) and Perugia (2008). He was a beacon to many; that and a highly valued friend to me.

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I have been knowing Andy Granato since 1969 when we met for the first time in Providence. Since then many times we had the opportunity of sharing our views at international meetings on internal friction and ultrasonic attenuation in solids. But I really became acquainted with him during my two years stay in Urbana working first with Howard Birnbaum and then with him. For me this was a most exciting period for life's and science's experience! I had the opportunity of admiring Andy's commitment to excellence. He was a scientific giant passionate about the science and the people. I appreciated him as advisor, coauthor, scientist, and last, but not least, as a friend. To my mind, besides his world-widely recognized scientific achievements were the qualities as a man that will be his longest-lasting legacy.

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I first knew and immediately enormously appreciated Andy Granato from his works on tunneling of interstitial H in metals. In particular, there were two articles on the paraelastic and dielastic response from two- and four-level systems, that were published in a totally unassuming manner in the Proceedings of the Eighth ICIFUAS Conference in Urbana, but contained so concisely and clearly written concepts and derivations of formulas that couldn't be found in any much longer review article or book. That was for me the starting and reference point for many years of research on H tunneling in metals. So, it was not only a honor to talk with him at subsequent ICIFUAS Conferences where we met, but also a surprise to discover what a pleasant person he was. Unfortunately, there has never been an opportunity for me to work with him, but at least I tried to miss no opportunity to talk with him at these Conferences, and among other things learn about his interstitialcy model on the solid-liquid transition.

It was thanks to this important contribution of him to the field of the glass transition that I was able to invite Granato to the 6th International Discussion Meeting on Relaxation in Complex Systems in Rome in 2009, and I was delighted to discover that Prof. Yosio Hiki, I also had invited to the same Conference, had been his former PhD student in Urbana. During this last visit to Rome, there was

also the opportunity for Andy Granato and Tetsu Ichitsubo, who also I had invited to the conference, to stay a while in my home, where Tetsu wonderfully played Mazzeppa of Liszt at the piano. It is impossible to separate the great scientific achievements of Andy Granato from the pleasant moments passed together.

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Condensed matter physicists in Russia know Professor Granato as one of the founders of the science on anelastic phenomena in solids. He was one of the authors of famous string dislocation model, which got worldwide recognition in the 70s of the past century and considered as one of the most cited models in condensed matter physics. Even nowadays, half a century later, one can find a description of this model in any textbook on anelastic properties of solids. The textbooks most often do not give exact citation of the papers by Professor Granato - it is assumed that any expert should know this model without any reference.

It is of no overestimation to say that most of the physicists working in the field of anelastic phenomena in Russia know the name Granato. When I was an undergraduate student in the middle of the 70s, we, young students, studied the string dislocation model and physics of dislocation damping developed by Granato and co-workers.

Much later, in 1993, I was lucky to meet Professor Granato at an internal friction conference in Rome. At that time, he worked on his Interstitialcy theory of condensed matter, which now is being more and more accepted providing a generic relationship between the properties of crystals and glasses. I was really happy to work with him for more than half a year in his laboratory at Physics Department at the University of Illinois at Urbana-Champaign. Since then, I have in the memory a clear image of a true intellectual and talented scientist. His death is an irreplaceable loss for the scientific community.

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