MOLECULAR AND QUANTUM ACOUSTICS IN POLAND THIRTIETH ANNIVERSARY?

Aleksander OPILSKI
Silesian University of Technology, Institute of Physics,
Bolesława Krzywoustego 2, 44-100 Gliwice

e-mail aopilski@zeus.polsl.gliwice.pl

1. INTRODUCTION

The anniversary of the School of Molecular and Quantum Acoustics is a good occasion to have some historical reflections. The thirtieth anniversary of the School is certainly not the day marking the beginning of the development of this branch in Poland. As it frequently happens, it started much earlier. The launch of every scientific discipline is accompanied by symptoms heralding the conception of new solutions, investigation studies and new interpretations. And also in the case of molecular and quantum acoustics in Poland and in the world the situation was similar.

The thirtieth anniversary of the School of Molecular and Quantum Acoustics in Poland is the time of intensive development of these disciplines, but we should allow for the fact that the foundation of the School resulted from the necessity and need to present scientific achievements and to exchange information and experience involving the development of the said branches accumulated for almost twenty years.

In order to acquaint the younger members of the School with the history involving the development of the branches in question I would like to present a historical outline covering the development of molecular and quantum acoustics in Poland in view of its development in the world.

2. HISTORICAL OUTLINE MARKING THE FOUNDATION OF MOLECULAR ACOUSTICS

1845-1851	G.G.Stokes – the first formulation of acoustic energy absorption effected by internal friction and thermal radiation.
1824-1887	G.R.Kirchhoff formulates the theories of acoustic wave attenuation effected by thermal conduction.
1911	N.Neklepajew – detailed measurements of the attenuation coefficient showed that apart from single-atom substances, it is considerably larger than it could be concluded from the Stokes-Kirchhoff theory
1935	Kneser – molecular theory of sound absorption in polyatomic gases
1959	Suttgart – apart from traditional sections (noise, architectonic acoustics, electroacoustics, room acoustics) for the first time the section of molecular acoustics is introduced; 46 papers were presented. Among others, the speeches were given by most meritorious scientists who heavily contributed to the development of molecular acoustics: W.P.Mason, K.Herzfeld, R.W.D.Stephens, T.A.Litovitz, W.Schaaffs and finally H.O.Kneser who was one of the organizers of the conference.

It can be seen from the above historical outline that molecular acoustics was founded as a separate field of acoustics, at the time when in the discussions involving the propagation of acoustic wave, for the first time the molecular and atomic structure of matter was given consideration to.

Molecular acoustics was formed along the line between two branches – molecular physics and acoustics. It is principally focused on the interaction between acoustic waves and matter, with the main emphasis placed on the utilization of ultra and hypersonic waves whereof wavelengths are comparable with the elements of the structure of matter.

3.HISTORICAL OUTLINE TRACING THE DEVELOPMENT OF MOLECULAR ACOUSTICS IN POLAND

In 1950s the investigation studies involving molecular acoustics were carried out in two scientific centers:
F.Kuczera – Chair of Physics WSR in Olsztyn
M.Puchalik – Medical Academy in Zabrze

In the mid and late 1950s, F.Kuczera and his coworkers (A.Opilski, S.Szyma) get into contact with overseas scientific centers Physikalisches Institut der Technischen Hochschule Stuttgart H.O. Kneser – lectures at the congress ICA 59, Laboratory of Molecular Acoustics Moscow W.F.Nozdriew, B.B.Kudriawcew.

At the same time, at the Adam Miskiewicz University, A Śliwiński is developing the methods of light diffraction on ultrasonic wave and the research on mixtures around the critical point. Simultaneously, the first works on sonochemistry come to light.

W.Wawrzyczek is completing a team at the Chair of Chemistry WSR in Olsztyn who investigate the influence of ultrasounds on the run of chemical reactions. A similar team is being created in Łódź by S.Witekowa and T.Witek. In 1960s and 1970s, E.Kowalska and W.Kowalski together with the team from the Silesian Unniversity of Technology are getting involved in the subject. In 1970s they are followed by B.Zapior and A.Juszkiewicz from the Jagiellonian University. The second half of 1950s as well as 1960s and 1970s are characteristic for the development of sonochamistry, and therefore Winter Schools had the term sonochemistry incorporated in the name.

Unfortunately, starting with 1980s, no works are carried out on the subject covering the problems closely related with sonochemistry, and therefore, in 1985, the name of Winter Schools was changed. Of course, it does not mean that in other scientific centers the works on that subject were no longer developed with the priorities as they are understood nowadays; the foundation of European Sonochemical Society is a proof thereof. At present, the branch of sonochmistry covers the influence of ultrasounds on cavitations, chemical synthesis, electrochemical processes, catalysis and others.

In 1960s the number of works on molecular acoustics is increasing, in IPPT R.Płowiec, Z.Kozłowski, in the Jagiellonian University M.Labowski, in the Aviation Institute W.Szachnowski and B.Wiślicki, the University of Warsaw L.Werblan, the Silesian University of Technology Z.Kleszczewski.

In the beginning of 1970s there arises a necessity to organize separate scientific meetings devoted to specific subjects. Initiated by F.Kuczera, A.Opilski and S.Szyma and accepted by other interested parties, a meeting was organized in 1971 at DW Kolejarz in Zakopane, followed by the foundation of Winter Schools of Molecular, Quantum Acoustics and Sonochemistry whereof the first took place in 1972 at DW Relax in Ustroń-Jaszowiec.

4.HISTORICAL OUTLINE MARKING THE FOUNDATION OF QUANTUM ACOUSTICS.

As it had been in the case of molecular acoustics, the formulation of the scope of quantum acoustics was preceded by a number of precursor works. In the initial years involving the development of the acoustics of solids, the mechanics of continuous medium was applied for the analysis of acoustic wave propagation. The application of that type of method has at least two limiting aspects. The application of rules of classical mechanics does not allow for the transfer of energy between two elements of the structure; such an interpretation is only true in the case of a continuous energy spectrum. The correct distribution of the field must allow for the fact that the length of the acoustic wave can be comparable with the modules of medium microstructure. The separation of energy levels is equivalent to the shift to the quantum approach of acoustic energy transport. With certain properties of the medium, parameters of the system and energy conditions, acoustic phenomena must be approached as quantum ones.

The precursors of quantum approach to vibration and quantum acoustics were:

1932 J.Frenkel – corpuscular presentation of an elastic disturbance wave , the notion o phonon.
1914 P.J.W.Debye – anharmonicity of thermal vibration.
1937 L.D.Landau, G.Rumer – phonic presentation of acoustic waves attenuation and their impact in nonlinear medium.
1956 Weinreich - he introduces an acoustoelectric effect.
1961 A.R.Hutson, J.H Mc Fee, D.L.White – amplification of ultrasonic wave in CdS
1961 In a number of elaborations Kaliski presents the reaction of acoustic wave with electromagnetic field.
1962 A.R.Hutson, L.White – the reaction of acoustic wave with charge carriers
1965-1968 a significant increase of works involving the generation and propagation of high-frequency waves (gigahertz).
1971 I.Malecki – symposium on acoustoelectronic problems (Sendai)
1971 I. Malecki – a book Theoretical fundamentals of quantum acoustics.

In 1970s also in Poland the problem of quantum acoustics attracts attention; the works are carried out in the following scientific centers:
Institute of Fundamental Technical Problems – I.Malecki, W.Pajewski, J.Ranachowski, M.Dobrzański, M.Aleksiejuk.
Military Academy of Technology – M.Szustakowski and coworkers.
Institute of Physics Silesian University of Technology – A.Opilski, Z.Kleszczewski, T.Pustelny, M.Urbńczyk and others.

5. PRESENT CONDITIONS OF MOLECULAR ACOUSTICS IN POLAND

There are three strong centers of molecular acoustics:
Institute of Chemistry, University of Silesia – S.Ernst and coworkers,
Institute of Physics, University of Gdańsk – A.Śliwiński, B.Linde and coworkers,
Institute of Acoustics, University of Poznań – M.Łabowski, T.Hornowski and others; there are also works carried out in:
IPPT – I.Malecki, R.Płowiec, University of Warsaw – M.Rzeszotarska, Silesian University of Technology – E.Soczkiewicz, WSP Częstochowa – I.Kityk and coworkers.

6. SECTION OF MOLECULAR AND QUANTUM ACOUSTICS.

The Schools of Molecular and Quantum Acoustics are run under the auspices of M&QA Section of the Polish Acoustics Society at Polish Academy of Science so it is worth while presenting its particular presidents.

1976 – following the resolution of the PTA Management Board, prof.A.Opilski was elected president.
1979-1983 – president prof. A.Śliwiński
1983-1989 – president prof. A.Opilski
1989-1992 – president prof. R.Płowiec
1992 – president prof. T.Pustelny.