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Scientific biography of Academician Ivan Juchnovski

Ivan Nikolov Juchnovski was born on 12 August 1937 in Sofia. In 1945 his family was exiled in the town of Sevlievo where he finished secondary school in 1955. In 1961 he graduated from the Higher Institute of Chemical Technology which is currently named University of Chemical Technology and Metallurgy (UCTM) in Sofia, as a chemical engineer with a major in Organic synthesis, pharmaceutical drugs and high-molecular compounds. From 1961 to 1963 Juchnovski worked in UCTM as an assistant professor in the Department of Organic Chemistry.

In 1963 Ivan Juchnovski began his work as a Junior scientist at the Institute of Organic Chemistry with Centre of Phytochemistry (IOCP) at the Bulgarian Academy of Sciences (BAS), Sofia where he defended his PhD in 1968. There Juchnovski acquired the academic rank associate professor in 1972. In 1982 he defended his doctor of sciences dissertation and became full professor in physical methods in organic chemistry in 1984. In 1989 Professor Juchnovski was elected a Corresponding Member of the Bulgarian Academy of Sciences, and in 1997 he became an Academician (Full Member).

In 1979 Professor Juchnovski established the Laboratory for Structural Organic Chemistry at IOCP and in 1989 he was elected Director of IOCP. From 1990 to 1996 he served as a Vice President of BAS. Between 1996 and 2008 Academician Ivan Juchnovski was elected three times President of the Bulgarian Academy of Sciences.

The scientific activity of Ivan Juchnovski began at a time when Bulgarian science was isolated from the free world: communication between scientists was limited, and publications of science papers needed permission from a special public institution. In a situation like this and despite the fact that throughout his career Prof. Juchnovski has never been on a specialization abroad, his ability to assign himself research tasks and find subject fields of high scientific significance was remarkable. Even during the time of his student's studies in the UCTM Juchnovski developed and issued research articles, and his PhD thesis was worked out without a scientific advisor. The scientific activity of Academician Ivan Juchnovski is extensively devoted to the study of electronic structure of conjugated organic compounds and the genetically related negative ions, which are intermediates in important organic reactions, by means of the combined application of infrared spectroscopy, quantum chemical methods, the correlation analysis and isotop labelled compounds.

There were established fundamental patterns in the transmission of polar effects of substituents through the systems of conjugated bonds on the characteristic frequencies and intensities, and particularly the exponential decrease of the polar effect of the substituents with the increase of the number of the double bonds in the polyen system. Later these patterns were approved by other authors. Juchnovski and co-workers proved that a number of considerable deviations of the correlations of characteristic frequencies are due to specific electronic effects of substituents (metha effect), incorrect assignment of frequencies, or vibrational interaction in molecules.

A new approach in modelling the derivative of the molecular dipol moment in nitrile group vibration was applied. By means of these model calculations on the basis of empiric and semi-empiric quantum chemical methods all fundamental relations of infrared band intensity in the spectra of the main types of conjugated compounds were explained. It was found that the integral intensity of the nitrile group band depends considerably on the topology of the conjugated system. The application of these model calculations enables the determination of the angles of deviation of aryl substituents in big conjugated molecules on the basis of infrared spectral data.

A considerable part of Prof. Juchnovski and co-workers' research activity has been devoted to studying the electronic structure and reactions of a wide range of negative ions of conjugated organic compounds: carbanions, azanions, anion-radicals, and dianions by means of their infrared spectra and quantum chemical calculations. The interest of these negative ions is due both to their high reactivity and instability, and to the fact that they are inetrmediates in important chemical reactions. For the most part the research was innovative.

In the course of studying carbanions which contain characteristic groups were established the major electronic ineractions, determining the character of vibrational spectra of carbanion systems: i) strong interaction between carbanionic centre and characteristic groups, leading to a considerable lowering of infrared frequencies and force constants; ii) competition for conjugation with carbanionic centre, leading to strong vibrational coupling between the groups connected to this centre.

In a dispute emerged in the society of chemistry about the presence of prototropic and metalotropic forms of metalated acetonitrile Juchnovski and co-authors demonstrated that this concept is wrong. Studying the infrared spectra of izotopically labelled acetonitrile they determined unconditionally that the observed infrared bands served as proof for by-products of chemical reactions, and not for the corresponding carbanion.

Spectral data for the carbanionic centre of saturated nitriles were obtained by means of infrared spectra: deviation from the planare structure was ascertained only for the anion of cyclopropylcianide; it was determined that the bond of studied carbanions with the corresponding counterions (Li+,Na+,K+) has an ion character.

On the basis of studying a large number of carbanionic systems fundamental patterns in the influence of conjugation and polar effects of the substituents over characteristic group frequencies and some skeletal vibrations of the carbanions were found and explained. It was established that the carbanion centre enhances the polar effects of substituents to a greater extent compared to all other groups with positive bridge effect. By means of the correlations of infrared frequencies and intensities sigma+ constants of series of carbanions and other anions with N- and O- substituents were determined. The latter were successfully applied for prediction of frequencies and intensities in series of various conjugated compounds.

The developed potential of infrared spectroscopy for studying instable and inseparable anion-radicals and carbanions and their transformations was demonstrated through the establishment of the convertability of dimerization of a number of anion-radicals to dimeric dianions and izomerisation of metoxide aducts of cyanobutadiens. In the course of this study there was proposed a new mechanism of disproporcionalization in Michler additions, whose general significance was later presented by other scientists.

Based on the infrared spectral study of representative groups of aromatic nitrile compound anion-radicals a number of important relations between the frequencies and intensities of nitrile groups were established. It was demonstrated that the particularly high sensitivity of the characteristic infrared frequencies is due to the intense mobility of the antibonding molecular orbital. An abnormal increase of nitrile group band intensity in the anion-radicals was found, which was explained by the electron charge mobility in the conjugated systems of these anion-radicals. It was demonstrated for the first time that this peculiarity of the antibonding orbital caused the strong vibroelectronic interaction in these systems.

A new infrared cell for electrochemical generation and spectral investigation of electron transfer products was invented, which helped the creation and study of infrared spectra of a variety of electrochemically generated anion-radicals and carbanions. The infrared spectra of anion-radicals of aromatic ketones (kethyles) were interpreted correctly for the first time by means of isotop labelled compounds, which led to the correction of a number of mistakes in band assignment and some corresponding findings concerning the influence of the structure over infrared spectra of these anion-radicals. It was shown that infrared spectroscopy could give information about the form of the orbital of the unpaired electron, as well as about the presence of separate, weak interactions between molecular fragments, which are due to the peculiar symmetry of this orbital.

Following the example of aromatic nitriles, infrared band spectral characteristics of extremely reactive dianions of aromatic nitriles were generated and studied for the first time. The observed experimental strong decrease of charcteristic frequencies of dianions in comparison with that of anion-radicals was theoretically explained. A number of significant capabilities of infrared spectroscopy for studying the electronic transfer between anion-radicals and dimeric

dianions were indicated. These capabilities of infrared spectroscopy were applied for studying the mechanism of the initiation and polymerization of several important monomers. Moreover, it was established that the initiation passes mainly from anion-radicals or dianions onto the monomer by means of electronic transfer, and the initiation ability depends on the electronic structure of the initiating agent.

During his career Prof. Juchnovski has published over 150 scientific papers, including (in co-authorship with Ivan Binev) the chapter *IR Spectra of Cyano and Isocyano Group, I. Juchnovski, I. Binev in The Chemistry of Functional Group, Suppl. C., S. Patai and Z. Rappoport (Eds), John Wiley, New York, 1983, Chapt. 4, pp. 107-135. Supplement C 1983, Hohn Wiley Ed. Z. Rappoport.*

Ivan Juchnovski started his teaching activity as an assistant professor at the UCTM. In 1963, together with Prof. A. Trifonov he began the first lecture course in Bulgaria in physical methods in organic chemistry, where he himself taught molecular spectroscopy to four-year students in the Faculty of Chemistry at Sofia University. He kept on delivering this lecture course for more than 20 years. In 1970 Juchnovski and Trifonov published the first textbook in Bulgaria on the discipline physical methods in organic chemistry.

Academician I. Juchnovski was the supervisor of 14 successful PhD students and a considerable number of Master's degree students. Some of his former associates from IOC in BAS have successful careers as researchers and teachers. Five of them became full professors, including two in Plovdiv University, and four became associate professors, one of whom acquired this academic rank at the University of Mining and Geology of Sofia.

For his teaching and scientific activity Academician I. Juchnovski was awarded the Honorary Sign with a Blue Band of Sofia University "St. Kliment Ohridski" (1997), Doctor Honoris Causa honorary degree of Plovdiv University "Paisii Hilendarski" (2001), Varna Free University "Chernorizets Hrabar" (2004), University of Chemical Technology and Metallurgy of Sofia (2005), University of Kharkov, Republic of Ukraine (2006). I. Juchnovski is a regular member of the European Academy of Sciences and Arts, Paris (2003) and member of the Leibnitz Society, Berlin. He is also an honorary citizen of the town of Sevlievo.

Academician I. Juchnovski is not only a distinguished specialist in the field of physical organic chemistry and a charismatic university lecturer. He has made many efforts and spent a lot of time in the applied science since the end of 1960s. This activity is connected mainly with the creation of many highly efficient and ecological technologies for the general and special galvanics, microelectronics, as well as with methods of preparing metal surfaces. These achievements were accomplished by the combined application of physical methods of analysis together with his fundamental study of organic synthesis, and electrochemical and other functional studies. In these explorative studies Prof. Juchnovski has been either the leader or one of the leaders in creating the fundamentals of galvanic additives production industry in Bulgaria. He is the author of 18 inventions (one patent recognized in the former USSR), in 14 of which he was the leading author; 15 of these inventions were introduced in tenths of plants in Bulgaria and in the former USSR, DDR and Czechoslovakia. These developments were introduced to the production of semi-products used in the additives BC-1, BC-2, in the production technology of the galvanic additives B7211 in Bulgaria, and in the automobile industry in the former USSR.

Another important contribution of Prof. Juchnovski and his team was the introduction in over 30 Bulgarian plants, and also in one plant abroad, of environmental technologies for bright acidic zinc electroplating with sulphate and chloride electrolytes. These technologies have replaced the usage of non-ecological and highly dangerous cyanide electrolytes for zinc coating in Bulgaria forever.

In 1974, for the invention of the technology of bright acidic copper electroplating, Prof. Juchnovski, together with two other scientists, was awarded the 'Dimitrov' prize - the most prestigious for the time prize for technical achievements. In 1980 Juchnovski was awarded the title "Honorary Inventor" for his activity in applied science, and in 1970 and 1972 he was awarded twice the prize "For contribution to technological progress". His name entered the „Golden Book" of inventors in Bulgaria in 1998. Academician I. Juchnovski received Prof. Asen Zlatarov Honorary Medal of the Union of Chemists in Bulgaria in 2001, the Honorary Sign of the Union of Bulgarian Scientists in 2004, and the Order of Stara Planina - first grade of the Republic of Bulgaria in 2004.

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