

THE TENTH ALL-UNION SYMPOSIUM AND THE FIRST ALL-UNION SCHOOL ON MOLECULAR SPECTROSCOPY OF HIGH AND SUPERHIGH RESOLUTIONS (2-9 June, 1991, Omsk)

A.I. Nadezhdinskii, V.I. Perevalov, Yu.N. Ponomarev, and L.N. Sinitza

On June 2-9, 1991, the regular tenth All-Union Symposium and the first All-Union School on molecular spectroscopy of high and superhigh resolutions were held in Omsk. The conference and school were held under the auspices of the Institute of Atmospheric Optics, Siberian Branch of the Academy of Sciences of the USSR, Omsk State University, Scientific Council on Spectroscopy of the Academy of Sciences of the USSR, and Board on Radiation at the Interdepartmental Geophysical Committee at the Presidium of the Academy of Sciences of the USSR. 132 scientists, who represented Moscow, Sankt-Peterburg, Tomsk, Novosibirsk, Omsk, Saratov, Nizhnii Novgorod, Khar'kov, Samarkand, Ufa, Ekaterinburg, Obninsk, Dnepropetrovsk, Uzhgorod, and Baku took part in the symposium.

Six leading specialists in the field of molecular spectroscopy from such European countries, as France, Italy, Spain, Germany, and Poland attended the symposium and the school in the capacity of invited lecturers.

Thirteen lectures, 33 oral, and 83 poster presentations have been delivered according to the following divisions: 1) theory of the spectra of molecules and radicals, 2) experimental investigations into the spectra of molecules in the gaseous phase with high resolution, 3) spectroscopy of the intermolecular interactions in gases, 4) new methods for the spectroscopy of molecular gases, 5) application of the high-resolution spectroscopy to atmospheric optics and gas analysis, and 6) high-resolution spectroscopy instrumentation.

Discussions on the division topics and a round table dedicated to the topic of intensity-fluctuation spectroscopy also took place during these events.

Below we briefly review the major materials presented at the symposium.

Division 1. Theory for the spectra of molecules and radicals

In recent years both quantitative and qualitative methods have been successfully developed in the theory of high-resolution molecular spectra. The following authors have dedicated their presentations to the development of the quantitative methods: A.V. Burenin (Asymptotically correct methods for description of the molecular states), V.F. Golovko (Pade approximants), S.N. Mikhailenko and O.V. Naumenko (New resonance types in the theory of nonrigid molecules), and so on. A feature peculiar to these symposium and school was a vivid discussions which dealt with the qualitative methods.

The problem of bifurcations in the high-resolution molecular spectra, whose consequence is clusterization of the energy levels or transition frequencies, was discussed in a lecture delivered by I.M. Pavlichenkov. In order to describe this phenomenon, a quasiclassical approach was used. In a number of theoretical reports this problem was examined for specific molecules, and some researchers

presented experimental data confirming the existence of bifurcations in the spectra such molecules as H_2Se and CF_4 .

A.V. Burenin directed his efforts to the problem of classification of the molecular states. He developed a classification scheme for the molecular states that was based on a chain of models, each of them being sheathed into the other, which revealed consecutive approximations when describing the molecular spectra. The scheme makes it possible to avoid many difficulties which arise when classifying the molecular states with the help of the Longe-Higgins groups.

L. Fuzina (Italy) treated the current state of the problem of describing the high-resolution spectra of the symmetric-top molecules.

R. Escribano (Spain) presented methods for identification of the high-resolution molecular spectra.

Ya. Makarevich (Poland) devoted his lecture to the theory of the high-resolution spectra of nonrigid triatomic molecules. The major premise of his approach to this problem is the rejection of the adiabatic approximation and the formulation of a self-consistent problem for the motion of the electrons and nuclei.

Division 2. Experimental investigations into the molecular spectra of the gaseous phase with high resolution

Analysis of the reports which have been presented at the symposium shows that currently quite a wide range of experimental setups and methods is employed in the experimental investigations into the molecular spectra. Among these setups and methods there are the Fourier spectrometers (A. Barbe, France), diode-laser spectrometers (A.I. Nadezhdinskii, V.M. Krivtsov, I. Pak, et al.), microwave spectrometers (N.M. Pozdeev, Sh.A. Ragimov, V.N. Markov, et al.), optoacoustic spectrometers (Yu.N. Ponomarev), and intracavity spectrometers (L.N. Sinitza and V.I. Ustyugov).

The presented reports indicate a significant improvement of the accuracy characteristics of the spectrometers. In the lectures delivered by A.I. Nadezhdinskii and L.N. Sinitza the situations in the diode laser spectroscopy and in the intracavity laser spectroscopy were comprehensively analyzed. The lecture by Yu.N. Ponomarev dealt with experimental investigations into the nonlinear spectroscopic effects in gases and their impact on the propagation of laser radiation in the atmosphere. A. Barbe treated the problem of studying the long-term trend for the ozone number density in the atmosphere and considered the question on the spectroscopic support of this problem.

Division 3. Spectroscopy of intermolecular interactions in gases

First of all it is pertinent to point out a substantial expansion of the experimental investigations in this field.

The second salient feature of Division 3 of the symposium was a great number of papers which dealt with theoretical and experimental investigations into the spectral–line shifts. Within the scope of this division two lectures on the theory of the spectral–line shape have been delivered (by M.V. Tonkov and M.L. Strekalov), in which the authors paid special attention to the problem of interference of spectral lines. One should pinpoint the report of M.P. Cherkasov, in which he analyzed the effect of the spectral line mixing on the shape of the spectral lines, and the papers by A.D. Bykov, in which new data on quantitative description of the line shifts owing to the pressure of buffer gases are presented. In the presentation by O.E. Rodimova some peculiarities of the continual and selective absorption in the wing of the CO₂ 4.3 μm band were explained by the phenomenon of spatial dispersion.

Division 4. New methods for spectroscopy of molecular gases

A new direction in the nonlinear spectroscopy which is aimed at employment of bi- and polychromatic saturating fields for the spectroscopy of simple quantum systems has been quite well manifested in this division. The lecture by W.E. Fradkin and the overwhelming majority of the other reports dealt with this topic.

One should point out a greater than before orientation toward applications. It was this problem that the round table, held inside this division, tackled.

Division 5. Application of the high–resolution spectroscopy to the atmospheric optics and gas analysis

The topics discussed within the scope of this division were mostly dedicated to applying the high–resolution spectroscopy to the atmospheric gas analysis. The methods of solar and long path absorption spectroscopy predominated in the presentations. Some reports treated other applications also. A particular meeting dealt with spectroscopic databases and banks. Here one should point out that the created databases are PC compatible, and that a great attention is paid to the problem of visualizing the spectroscopic information.

Division 6. High–resolution spectroscopy instrumentation

First of all one should pinpoint the lecture delivered by Zh.Zh. Platu (France), in which he reported that a new Fourier spectrometer, which is superior to the available analogs with respect to a number of the parameters, had been constructed in Reims. As regards the compatriots, it is pertinent to point out V.N. Markov and E.A. Alekseev who presented recent achievements in the microwave spectroscopy. The use of fiber optics in the middle IR provides new potentialities for the diode–laser spectroscopy (E.V. Stepanov). One should also point out an interesting report by V.I. Ustyugov which dealt with the problems of intracavity laser spectroscopy.

Round table. Spectroscopy of the intensity fluctuations

The participants of the round table pointed out that a number of experimental groups had demonstrated the maximum achievable measurement sensitivity limited only by shot–noise fluctuations in the detection channel of the spectrometers. An additional increase in the sensitivity is feasible only when employing light sources with noise level lower than the standard quantum limit. The problems of constructing such sources and prospects for their applications to the spectroscopic research were also discussed. One should especially pinpoint that some experimental works in this field have appeared in our country (Ya.A. Fofonov).

During the final plenary discussion it was noted the convenience, for young scientists, of participating in such a joint event on the molecular spectroscopy like this symposium and the school. The participation of the invited Soviet and foreign scientists, who reviewed the main problems of the molecular spectroscopy, and the presence of original presentations dealing with the same topics have ensured a high scientific and cognitive level of the conference.

The symposium participants have agreed that it would be advisable to combine the symposium on the high–resolution molecular spectroscopy and the school with subsequent transformation of these events from the All–Union into the International status and also formulated a number of recommendations concerning the measures aimed at the intensifying the international and intra–union cooperation.