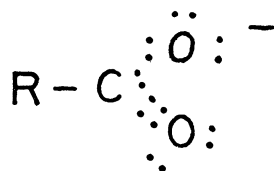
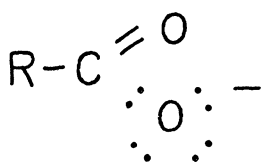


A Soviet Marxist View of Structural Chemistry: The Theory of Resonance Controversy

By Loren R. Graham *

THE INADEQUACY OF classical bond diagrams in depicting important chemical compounds has been known from the very beginning of structural chemistry. Certain compounds cannot be described in terms of any one classical structure. Instead, these compounds must be described as "intermediate" structures which contain nonintegral bonds. The resonance theory of valency, developed around 1930 by Linus Pauling and further expanded by G. W. Wheland, is an attempt to explain this structural phenomenon.¹

The significance of the resonance theory according to Wheland is that "it is considered possible for the true state of a molecule to be not identical with that represented by any single classical valence-bond structure, but to be intermediate between those represented by two or more different valence-bond structures."² Such an intermediate structure is known as a "resonance hybrid." Structural chemists have described many such hybrids. The two valence-bond structures "contributing" to the carboxylate ion are:³



* Indiana University. The author is grateful to the Inter-University Committee on Travel Grants, the Ford Foundation, and the Danforth Foundation for grants to do research on Soviet science.

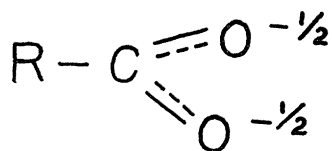
¹ The resonance theory was anticipated in the nineteen-twenties by several German and English chemists, especially C. K. Ingold in England. Ingold called his particular version of essentially the same phenomenon "mesomerism," a more accurate description since it means literally "between the forms." "Reson-

ance," on the other hand, connotes movement, which does not occur in chemical resonance. The term "resonating system," often used by chemists, is even less precise.

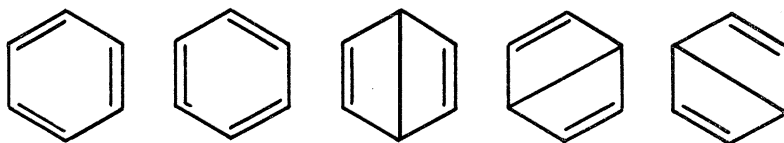
² G. W. Wheland, *Resonance in Organic Chemistry* (New York, 1955), p. 3.

³ These configurations for the resonance structures of carboxylate ions are given in Linus Pauling, *The Nature of the Chemical Bond and the Structure of Molecules and Crystals: An Introduction to Modern Structural Chemistry* (Ithaca, 1960), p. 275.

The resonance hybrid for the carboxylate ion is usually drawn:



More familiar is the case of benzene. Five different structures, the Kekulé and Dewar ideal forms, are considered to be contributing to the hybrid: ⁴



Wheland repeatedly reminded his readers that resonance should be regarded not as any sort of oscillation between the above structures, but as a word referring to a molecule in a permanent hybrid state.⁵ The five structures are merely aids for descriptive purposes and never, in fact, exist.⁶ On this point Pauling has commented:

We might say . . . that the molecule cannot be satisfactorily represented by any single valence-bond structure and abandon the effort to correlate its structure and properties with those of other molecules. By using valence-bond structures as the basis for discussion, however, with the aid of the concept of resonance, we are able to account for the properties of the molecule in terms of those of other molecules in a straightforward and simple way. It is for this practical reason that we find it convenient to speak of the resonance of molecules among several electronic structures.⁷

According to the theory of resonance, the bonds between the carbon atoms in benzene would be neither single nor double bonds, but a type of bond between the two, roughly described, perhaps, as a $1\frac{1}{2}$ or $1\frac{1}{3}$ bond. Such a description is supported by electron diffraction and infrared spectroscopic examinations which show that while the distance between carbon atoms connected by a single bond is about 1.54 Angstrom units and by double bonds is 1.33 units, the measurement for benzene bonds is 1.40, between that of a double and that of a single bond.⁸

Although, as Pauling has emphasized, the theory of resonance does not rest upon quantum mechanics in its conception, a quantum-mechanical

⁴ These structures should not be thought of as isomers or tautomers. The latter exist, whereas the resonance forms do not.

⁵ Wheland, *op. cit.*, pp. 7-8.

⁶ *Ibid.*, p. 4.

⁷ Linus Pauling, *op. cit.*, p. 186.

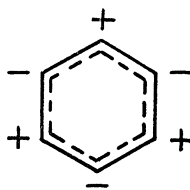
⁸ More exactly, the C-C bond (single) length

in ethane is $1.536 \pm 0.016\text{\AA}$, the C-C bond length in benzene is $1.393 \pm 0.005\text{\AA}$, and the C-C bond (double) length in ethylene is $1.330 \pm 0.005\text{\AA}$. *Tables of Interatomic Distances and Configuration in Molecules and Ions* (London, 1958), pp. M135, M196, M129.

method of calculation is utilized in computing certain properties of the molecules, such as stability during reactions. A wave function, or Schrödinger equation, is written for each of the idealized, or "resonance," structures, and then the wave functions are combined in a purely linear fashion, that is, by simple addition.⁹

Pauling's elaboration of the theory of resonance was known in the Soviet Union long before World War II; many years passed before the theory of chemical bonds attracted any particular ideological attention. The resonance theory became popular among many chemists in the Soviet Union. After the war two Soviet chemists, Ia. K. Syrkin and M. E. Diatkina, appeared with their own treatment of resonance in the book *The Chemical Bond and the Structure of Molecules*, which Pauling described as an "excellent work." He added that, in his opinion, Syrkin and Diatkina "are among the most able [chemists] in Russia today."¹⁰

The resonance controversy was initiated by a zealous, ambitious, but undistinguished chemist, Gennadi V. Chelintsev, who was later accused of trying to gain the supreme position in chemistry which Trofim D. Lysenko had won in biology. In 1949 Chelintsev, a professor of chemical warfare at the Voroshilov Military Academy, published a book entitled *Essays on the Theory of Organic Chemistry* in which he proposed explaining molecular structure in a way that would not include the approximate methods of quantum mechanics and would not require the use of more than one formula for one compound. In particular, he said the formula for benzene should be drawn, not on the basis of covalent bonds, but on the basis of electrovalent, or ionic, bonds.¹¹ Chelintsev would represent benzene in the following way:¹²



The dotted line signified, to Chelintsev, "the levelling out" of the electronic charge. According to him there are no double bonds in benzene at all. He maintained that the theory of resonance not only was sterile methodologically, but also introduced a "mechanistic" concept into chemistry, filling a gap in man's knowledge with an unrealistic but comforting mechanical description.

The appearance of Chelintsev's book elevated the theory of resonance to the platform of ideological discussion. Regardless of the scientific compe-

⁹ A weighting factor is applied to each equation, depending on the amount of "influence" each ideal structure exercises.

¹⁰ "Soviets Blast Pauling, Repudiate Resonance Theory," *Chemical and Engineering News*, September 10, 1951, 29: 3713. See also Ia.

K. Syrkin and M. E. Diatkina, *Khimicheskaia Sviaz' i Stroenie Molekul* (Moscow, 1946).

¹¹ G. V. Chelintsev, *Ocherki po Teorii Organicheskoi Khimii* (Moscow, 1949), pp. 107-108.

¹² *Ibid.*, p. 108.

tence of Chelintsev, the use of ideal structures, which he had called "mechanistic," also made the theory appear in the traditionally intolerable camp of "idealism."

The Communist party had taken an aggressive ideological attitude in several sciences; the 1948 culmination of the Lysenko affair was followed by a whole series of debates. Certain common characteristics marked these controversies. Usually an all-Union conference was eventually held for each science, which hundreds of scientists specializing in that particular science attended. At this conference the theories of certain scientists were rejected, and one theory, often represented by a single scientist, emerged as the one most progressive and consistent with dialectical materialism. Such a conference occurred in agricultural biology from July 31 to August 7, 1948, where Lysenko's theories were confirmed.¹³ Conferences for the astronomers were held December 13 to 14, 1948, and April 16 to 19, 1951, and O. Iu. Schmidt's cosmogonical theories received very heavy support.¹⁴ During the period March 22 to 24, 1950, a joint conference of the biological section of the Academy of Sciences and the Academy of Medical Sciences confirmed Olga Lepeshinskaia's theories concerning the derivation of cells from living noncellular substances.¹⁵ A joint session of psychologists and physiologists, held June 28 to July 4, 1950, approved the theories of the late Russian scientist I. P. Pavlov.¹⁶ The conference concerning the theory of resonance was to come near the end of this period, from June 10 to 14, 1951. A victory for the same militant forces seemed likely.¹⁷

That the theory of resonance should be considered ideologically untenable was made clear by V. M. Tatevskii and M. I. Shakhparanov in the article "On a Machist Theory in Chemistry and Its Propagandists," which appeared in *Voprosy Filosofii* in the fall issue, 1949.¹⁸ In this article the two authors selected for criticism Wheland's description of resonance as a man-made concept which "does not reflect any inner property of the molecule itself, but is a mathematical method invented by the physicist or chemist for his own convenience."¹⁹

Recalling that Lenin in describing his "copy-theory of matter" had

¹³ The record of this conference is available in both Russian and English. The English translation is: *The Situation in Biological Science. Proceedings of the Lenin Academy of Agricultural Sciences of the U. S. S. R. (July 31-August 7, 1948) Verbatim Report* (Moscow, 1949). The Russian edition is: *O Polozhenii v Biologicheskoi Nauke. Stenograficheskii Otchet Sessii Vsesoiuznoi Akademii Sel'sko Khoziaistvennykh Nauk Imeni V. I. Lenina, 31 Iulia-7 Avgusta 1948 g.* (Moscow, 1948).

¹⁴ For the 1951 cosmogonical conference, see V. S. Safronov, "Problema Proiskhozhdeniia Zemli i Planet: Soveshchanie po Voprosam Kosmogonii Solnechnoi Sistemy," *Vestnik Akademii Nauk SSSR*, 1951, no. 10: 94-102.

¹⁵ See A. I. Oparin, "O Nekletochnykh Formakh Zhizni i Proiskhozhdenii Kletok," *Vest-*

nik Akademii Nauk SSSR, 1950, no. 7: 119-122.

¹⁶ The English report of this conference is: *Scientific Session on the Teachings of Pavlov* (Moscow, 1951). The Russian edition is: *Nauchnaia Sessia Posviashchennaia Probleme Fiziologicheskogo Ucheniia Akademika I. P. Pavlova 28 Iiunia-4 Iiulia 1950 g.* (Moscow, 1950).

¹⁷ For a discussion of the ideological disputes in the various sciences, see Gustav Wetter, *Dialectical Materialism: A Historical and Systematic Survey of Philosophy in the Soviet Union* (New York, 1958), pp. 405-487.

¹⁸ V. M. Tatevskii and M. I. Shakhparanov, "Ob Odnoi Makhistskoi Teorii v Khimii i Ee Propagandistakh," *Voprosy Filosofii*, 1949, no. 3: 176-192.

¹⁹ *Ibid.*, p. 177.

insisted that ideas and sensations are images of objects existing outside of the human mind, Shakhparanov and Tatevskii affirmed that it would be ideologically incorrect to describe molecules in terms of ideal, or physically impossible, structures.²⁰ The primary fault of the resonance theory, according to the authors, was that it utilized more than one structure while insisting that no transformation back and forth between the forms occurred. Thus, the theory of resonance had become "divorced from reality."

Tatevskii and Shakhparanov maintained that the use of quantum mechanics, a valuable aid to science, does not in any way account for this concept of multiple ideal forms. They charged Wheland and Pauling with trying to conceal their ignorance of the true nature of molecules with an explanation created out of thin air.

By 1950 Soviet philosophers had adopted a particular viewpoint toward quantum mechanics, not rare among physicists and philosophers in general, which must be noted. After a great deal of vacillation the Soviet scholars, under the direction of the Communist party, approved quantum mechanics as a method, but insisted that approximate methods of calculation do not lead to a denial of causality. The official Soviet viewpoint was that molecular particles only appear to be fortuitous in motion. At the present state of science, the Russian scientists said, the inadequate tool of quantum mechanics is the only method available for studying such particles. But in the future, they continued, new laws of motion and matter will be discovered which will reveal the inherent order in the realm of molecular particles, and quantum mechanics will then appear to be as incomplete a method of calculation as classical physics did in its turn.²¹ Thus, the Soviet scholars agreed with such Western scientists as David Bohm and Louis de Broglie, who seek to eliminate the necessity of approaching elemental particles from a statistical standpoint.

The position taken by Tatevskii and Shakhparanov on resonance theory was paralleled closely by unsigned articles which appeared in *Zhurnal Fizicheskoi Khimii* and in *Pravda* commemorating Stalin's seventieth birth-

²⁰ In his criticism of the Austrian scientist and philosopher Ernst Mach, Lenin stressed two tenets of dialectical materialism which became particularly important in the later Soviet discussions of ideology in the physical sciences. These were his "copy-theory" of the mind-matter relationship and the principle that there can be no movement without matter and no matter without movement. By the "copy-theory," Lenin meant that materialism is based on recognition of "objects in themselves." According to him, "ideas and sensations are copies or images of these objects." On the relationship of matter and movement, Lenin wrote, "What is essential is that the attempt to *think* of motion without matter smuggles in *thought* divorced from matter—and that is philosophical idealism." V. I.

Lenin, *Materialism and Empirio-Criticism: Critical Comments on a Reactionary Philosophy* (Moscow, 1952), pp. 17, 277.

²¹ For Soviet viewpoints on quantum mechanics and causality in physics, both during and after the Stalinist period, see: A. A. Maximov, I. V. Kuznetsov, Y. P. Terletskii, and N. F. Ovchinnikov (editors), *Filosofskie Voprosy Sovremennoi Fiziki* (Moscow, 1952); M. E. Omelianovskii, *Filosofskie Voprosy Kvantovoi Mekhaniki* (Moscow, 1956); M. I. Shakhparanov, *Dialekticheskii Materializm i Nekotorye Problemy Fiziki i Khimii* (Moscow, 1958); I. V. Kuznetsov, N. F. Ovchinnikov, and M. E. Omelianovskii (editors), *Problema Prichinnosti v Sovremennoi Fizike* (Moscow, 1960); and G. A. Svechnikov, *Kategorii Prichinnosti v Fizike* (Moscow, 1961).

day.²² The authors of the articles asked that defects in Soviet science, especially in chemistry, be eliminated.

The discussions of the resonance theory contained many references to a nineteenth-century Russian chemist, Alexander Mikhailovich Butlerov, whom Soviet historians of science have called "the founder of structural chemistry." Butlerov, a professor of chemistry at the universities of Kazan and St. Petersburg, and a member of the Imperial Academy of Sciences from 1874 to 1886, is hardly ever mentioned in Western textbooks or histories of chemistry. Little doubt exists that he deserves more attention.²³ In 1940, before the resonance controversy erupted in the Soviet Union, an American, Henry M. Leicester, wrote a biographical article on Butlerov, lauding the Russian chemist for his advanced studies in the field of organic chemistry.²⁴ In 1953 a French chemist, J. Jacques, asserted that the name of Butlerov should have equal prominence with Friedrich Kekulé in the development of theories of molecular structure.²⁵ In the 1960 edition of his book *The Nature of the Chemical Bond*, Linus Pauling, the target of the most vociferous attacks of the Soviet ideologues, gave credit to Butlerov for his work on valency, although in the earlier editions Pauling did not mention Butlerov.²⁶ Professor I. M. Hunsberger has given what seems to be a fair evaluation of Butlerov's achievements: "There is no doubt whatsoever that Butlerov has not received the credit he richly deserves and that his monumental contributions to organic structural theory have been for the most part virtually overlooked. . . . Butlerov's contributions certainly equal those of Kekulé and Couper, but it is ridiculous to maintain that Butlerov is the *sole* author of structural theory."²⁷ Mistakes in historical interpretation are corrected only with difficulty, however; the 1955 edition of the *Encyclopaedia Britannica* devoted one whole column to Kekulé but did not even list Butlerov. The 1963 edition contains one paragraph on Butlerov.

Butlerov's views on molecular structure differed from those of such chemists as Charles Gerhardt, who did not believe that formulas represent any sort of reality. Kekulé himself never attributed much physical significance to his formulas; he tended to regard them only as symbols for explaining reactions. Butlerov, on the contrary, believed that one substance should have one structural formula. He remarked: "If we attempt now to define the chemical structure of substances and if we have success in expressing it

²² "K 70-Letiiu co Dnia Rozhdeniia I. V. Stalina," *Zhurnal Fizicheskoi Khimii*, 1949, no. 12: 1385-1386; *Pravda*, December 17, 1949, p. 1.

²³ A biographical article on Butlerov and additional bibliographical information may be found in *Russkii Biograficheskii Slovar'*, Vol. III (St. Petersburg, 1908), pp. 528-533. For longer but less reliable articles, see *Bo'shaia Sovetskaia Entsiklopedia*, Vol. VI (Moscow, 1951), pp. 378-383 and 383-389.

²⁴ Henry M. Leicester, "Alexander Mikhailovich Butlerov," *Journal of Chemical Education*, 1940, 17: 203-209.

²⁵ J. Jacques, "Boutlerov, Couper et la Societe chimique de Paris (Notes pour servir a l'histoire des theories de la structure chimique)," *Bulletin de la Société chimique de France*, 1953, 528-530. Butlerov knew Kekulé and visited his laboratory.

²⁶ Linus Pauling, *op. cit.*, p. 4. The earlier editions of the book were published in 1939 and 1944.

²⁷ I. M. Hunsberger, "Theoretical Chemistry in Russia," *Journal of Chemical Education*, 1954, 31: 506.

by our formulas, then those formulas will be, although not completely, real rational formulas. . . . For each substance there will be, therefore, one rational formula, and when the general laws of the properties of substances are well-known, such a formula will express all of these properties.”²⁸ Quotes such as this were convenient for Soviet authors criticizing the multiple forms of the resonance theory.

From February 2 to 7, 1950, the Institute of Organic Chemistry of the Academy of Sciences conducted a discussion on modern theories of organic chemistry.²⁹ Later Chelintsev criticized most of the men who wrote the main report, including the chairman, D. N. Kursanov, on the grounds that they themselves were guilty of believing in resonance theory. In this report, entitled “The Present State of Chemical Structural Theory,” and in several other articles which appeared at this time, four main points seemed paramount: (1) Butlerov was the true founder of the theory of chemical structure; (2) the theory of resonance is idealistic and, therefore, unacceptable; (3) although resonance must be rejected, quantum mechanics is essential for scientific research, and a clear line can be drawn between the theory of resonance and quantum mechanics; (4) G. V. Chelintsev is not a competent scientist, although he played a positive role in drawing the attention of Soviet chemists to the necessity for a critical analysis of resonance theory.³⁰ As time progressed, points 3 and 4 became increasingly important. An effort was clearly being made during 1950 to discredit Chelintsev and simultaneously rally as many scientists as possible to the defense of quantum-mechanical methods of calculation in chemistry.

From June 11 to 14, 1951, the theory of resonance was the topic of discussion of an all-Union conference on the theory of chemical structure, attended not only by chemists, but also by hundreds of physicists, philosophers, and educators.³¹ The Bureau of the Division of Chemical Sciences of the Academy of Sciences organized a commission headed by A. N. Nesmeianov, the President of the Academy, to prepare the major report, but the report was actually given by A. N. Terenin, rather than by Nesmeianov, who was ill and did not attend. A total of forty-four delegates gave speeches, many of them similar in content, but there were several surprisingly heated debates, in spite of the fact that not one person defended the theory of resonance. The previous articles and discussions had already set the stage for

²⁸ Quoted from S. N. Danilov, “A. M. Butlerov — Osnovatel’ Teorii Khimicheskogo Stroeniia (1861-1951),” *Zhurnal Obshchei Khimii*, 1951, 21: 1740.

²⁹ See “Na Uchenom Sovete Instituta Organicheskoi Khimii AN SSSR,” *Izvestiia Akademii Nauk, Otdelenie Khimicheskikh Nauk*, 1950, no. 4: 438-444.

³⁰ See D. N. Kursanov, *et al.*, “K Voprosu o Sovremennom Sostoianii Teorii Khimicheskogo Stroeniia,” *Uspekhi Khimii*, 1950, 19: 537 ff. Other important articles on resonance theory and Butlerov which appeared at this time included: S. N. Danilov, “Molekuliarnye Pere-

gruppirovki Organicheskikh Soedinenii v Svete Teorii Stroeniia Butlerova,” *Zhurnal Obshchei Khimii*, 1950, 20: 2301-2313; O. A. Reutov, “O Nekotorikh Voprosakh Teorii Organicheskoi Khimii,” *Zhurnal Obshchei Khimii*, 1951, 21: 186-199; V. M. Tatevskii, “O Teorii Rezonansa,” *Zhurnal Fizicheskoi Khimii*, 1950, 24: 597-640.

³¹ The verbatim record of this conference has been published: *Sostoianie Teorii Khimicheskogo Stroeniia, Vsesoiuznoe Soveshchanie 11-14 Iiunia 1951 g.: Stenograficheskii Otchet* (Moscow, 1952).

the conference so that it was a foregone conclusion that resonance would be rejected. The real issue was the extent to which Western theories of structural chemistry must be condemned. The increasingly pathetic Chelintsev continued to make ineffective attacks against his fellow chemists.

In the main report, Academician Terenin and his co-workers again isolated the error of resonance as being specifically the use of fictitious structures.³² Terenin pointed out that any empirical data on the properties of molecules are, of course, perfectly acceptable and usable. Therefore, as long as the Soviet chemists did not resort to computations derived from fictitious structures, they could use all of the data which they could collect concerning molecules, even the mathematical expressions of this data, which, if represented in physical terms, would logically lead to the contradictions of incompatible physical forms. This alternative approach which avoided the ideal structures was named the "theory of mutual influences," borrowing a phrase from Butlerov. The Soviet explanation of the apparent contradiction in this explanation of molecular forms was the inadequacy of man's knowledge of structural chemistry at the current time.³³ Eventually the knowledge of chemical bonds will advance to the point that this contradiction will be resolved. Whatever that final answer may be, it cannot possibly be the theory of resonance, which is a blind alley postulating that the form of a molecule is physically inconceivable. The theory of resonance leads to agnosticism, said the Soviet chemists, which is the Kantian belief that man's knowledge of truth cannot go beyond certain limits.³⁴

The difference between the theory of resonance and the theory of mutual influences is exceedingly subtle. Epistemologically, there is a difference; Soviet chemists could not conclude that molecules are intellectual forms, nor that molecules can be explained only in terms of intellectual forms, no matter how overpowering the evidence for one of these alternatives might be. The primary practical distinction between the method suggested by the Soviet chemists and the theory of resonance is that the Soviets would be deprived of the use of resonance forms as instructional "visual-aids."

Professor Chelintsev fiercely tore into the report. The whole conference, he maintained, was failing its task; it was supposed to reject the theories of Pauling and C. K. Ingold, but, on the contrary, it had been taken over by the partisans of these two foreign scientists. He added that the theory of mutual influences is only a modification in nomenclature of the mesomerism-resonance theory.³⁵ "The authors of the report," he accused, "were given the assignment of saving the beloved heart of Ingold's and Pauling's mesomerism-resonance theory."³⁶ Chelintsev said that the leaders of the con-

³² *Ibid.*, p. 67.

³³ *Ibid.*, pp. 47 ff.

³⁴ The Soviet view is that objective reality exists apart from the human mind and that scientists must strive toward absolute explanations, even if these explanations are never reached. Engels wrote that the relationship between man's knowledge and truth is asymp-

totic. At the point of infinity in that relationship complete truth exists. See Frederick Engels, *Herr Eugen Dühring's Revolution in Science (Anti-Dühring)* (New York, 1939), p. 326.

³⁵ *Sostoianie Teorii Khimicheskogo Stroeniia*, pp. 81, 86.

³⁶ *Ibid.*

ference had suppressed his articles and had camouflaged the resonance theory.³⁷ Chelintsev, no doubt feeling frustrated in his desire to duplicate Lysenko's feat in biology, commented: "This is the first case in the course of the recent scientific-methodological discussions when the approved report advances not a criticism of the mistakes but a plea of guilt in their behalf, representing, moreover, not an isolated person, but the commission which was named by the Department of Chemical Sciences of the Academy of Sciences of the USSR, and approved, surely, by the Presidium of the Academy."³⁸

Chelintsev noted that he considered it his duty to name the most active propagandists of the resonance theory; he began with the President of the Academy of Sciences, A. N. Nesmeianov, and named twenty-six³⁹ of the top chemists in the Soviet Union. Almost all the authors of articles denouncing resonance which had appeared in the last two years were on the list, including Tatevskii and Shakhparanov, whose article in late 1949 had been so important in publicizing the "correct" ideological position towards resonance. Five of the nine members of the commission of the Department of Chemical Sciences which had investigated the resonance theory in February, 1950, were named, and six of eleven of the scientists designated to compile the report for the June, 1951, all-Union conference were also listed.

One of the speakers who followed Chelintsev was the philosopher A. A. Maximov, a member of the editorial committee of *Voprosy Filosofii*. Maximov had been involved in a long series of squabbles concerning ideology and science. He plumbed Chelintsev's motives with his remark: "According to Chelintsev, he is assuming the role in chemistry of T. D. Lysenko, and the 'Pauling-Ingoldites' named by him are playing the roles of Weismann-Morganists."⁴⁰ Maximov also affirmed: "I know the members of the commission and the 'Pauling-Ingoldites.' . . . I consider them honest, devoted Soviet chemists sparked by desires for Soviet chemistry to flourish."⁴¹

When the conference prepared to vote on the final resolution, Chelintsev rose to say that although he had been a member of the commission in charge of drafting the resolution, he had been completely outnumbered by the "Paulingites and Ingoldites," and consequently his vote had not exercised any influence.⁴² In the final vote the three or four delegates who had supported Chelintsev on earlier matters deserted him and he alone opposed the resolution.⁴³

The resolution approved the essence of the report of the Chemical Section

³⁷ *Ibid.*, pp. 86-87.

³⁸ *Ibid.*, pp. 79-80.

³⁹ *Ibid.*, p. 87. Chelintsev named Academicians A. N. Nesmeianov, A. N. Terenin, B. A. Kazanskii; Member of the Ukrainian Academy of Sciences A. I. Kiprianov; Corresponding members of the USSR Academy of Sciences Ia. K. Syrkin, V. N. Kondratiev, I. L. Knunians, A. I. Brodskii; professors and doctors of sciences M. V. Volkenshteyn, M. I. Kabachnik, D. N. Kursanov, R. Kh. Freidlina, M. E. Diat-

kina, D. A. Bochvar, B. M. Berkenheim, A. P. Terentiev, B. A. Ismailskii, B. M. Mikhailov, A. Ia. Iakubovich, A. I. Titov, L. I. Smorgonskii, M. G. Gonikberg; "docents" and "candidates" of sciences V. M. Tatevskii, M. I. Shakhparanov, M. D. Sokolov, and O. A. Reutov.

⁴⁰ *Ibid.*, pp. 259-260.

⁴¹ *Ibid.*, pp. 255-256.

⁴² *Ibid.*, p. 365.

⁴³ *Ibid.*, p. 370.

of the Academy of Sciences which Professor Terenin had read at the beginning of the conference, but noted several "serious defects" in that report. First of all, the report had not illustrated that the perversions in chemistry were closely connected with those in biology and physiology, and all of these hostile theories "present a united front in the fight of reactionary bourgeois idealism against materialism."⁴⁴ Another defect of Terenin's report was its failure to describe adequately the great progress of Soviet chemistry.⁴⁵

The peak of the resonance controversy was passed with the end of the all-Union conference. Since then numerous articles touching on the controversy have appeared, but the essential position taken by the conference has remained unaltered. Although the influence of ideology on Soviet science has greatly decreased since Stalin's death, the theory of resonance has remained unacceptable. One of the most complete criticisms of the resonance theory which has appeared since the conference is M. I. Shakhparanov's pamphlet *Dialekticheskii Materializm i Nekotorye Problemy Fiziki i Khimii*, (*Dialectical Materialism and Several Problems of Physics and Chemistry*), published in Moscow in 1958 and written by the same chemist who assisted Tatevskii in writing the 1949 article. Shakhparanov's booklet was notable for two reasons: he de-emphasized ideological criticism of the theory of resonance, maintaining that it is incorrect also for obvious scientific reasons; and he modified the remaining ideological objections to the theory.

Shakhparanov noted that the discussion of the theory of resonance in the Soviet Union had been debated abroad, and that some foreign chemists, particularly in England and Japan, had also criticized the theory.⁴⁶ Although these scientists did not propose superior alternatives to the theory, they believed that the use of fictitious structures for explaining the properties of compounds was only a temporary method.

Shakhparanov indicated that in the United States the Soviet criticism of resonance had been misrepresented as being purely ideological,⁴⁷ thus implying that if the Soviet criticism had been purely ideological, its value would have been weaker. This view is a departure from the traditional insistence of Soviet philosophers on the identity of dialectical materialism with science. Nevertheless, Shakhparanov also criticized resonance on the basis of Lenin's statement that any attempt *to think* of movement without matter is philosophical idealism.⁴⁸ Shakhparanov asserted that in resonance the movement of mental forms occurs.

⁴⁴ *Ibid.*, p. 376.

⁴⁵ These defects were "corrected" in a revised report; see *Sostoianie Teorii Khimicheskogo Stroeniia* (Moscow, 1954).

⁴⁶ For example, one Western critic said "the resonance theory stands in danger of being largely discredited, at least in so far as it has been applied hitherto. . . . It must never be forgotten that the theory ultimately depends

upon the use of limiting structures which, by admission, have no existence in reality." Note of L. H. Long, translator of Walter Huckel, *Structural Chemistry of Inorganic Compounds* (New York, 1950), p. 437.

⁴⁷ M. I. Shakhparanov, *Dialekticheskii Materializm i Nekotorye Problemy Fiziki i Khimii* (Moscow, 1958), p. 86.

⁴⁸ *Ibid.*, p. 81.

With the exception of the reference to Lenin, the objections of Shakhparanov are similar to those of many non-Marxists who meet the theory of resonance for the first time or who are unfamiliar with the inadequacy of traditional physical descriptions for explaining molecular phenomena. Shakhparanov's complaints are not as uniquely "Soviet" as previous criticisms of resonance; there is less parroting of "Machism," "agnosticism," or "mechanism" — those terms which have meaning primarily for a person initiated in the vocabulary of dialectical materialism and which were flaunted so habitually in the early debate.

When the author of this article studied at Moscow University during the 1960-1961 academic year, he found that Soviet chemists speak of the controversy as having "blown over," but admit that the term "resonance" is not used in chemistry lectures on valency and that standard textbooks in structural chemistry continue to avoid the resonance theory. There are some signs that the official attitude toward resonance theory may have changed recently. In November, 1961, Dr. Pauling lectured on resonance at the Institute for Organic Chemistry in Moscow to an audience of about twelve hundred people; Pauling believes that his lecture was favorably received.⁴⁹ On March 26, 1962, Professor Peter Kapitsa, the outstanding Soviet physicist, criticized the attitude of Soviet philosophers toward resonance theory, as well as their attitudes toward the theory of relativity, Heisenberg's indeterminacy principle, genetics, and cybernetics.⁵⁰

If the interpretation of the resonance controversy presented in this article is correct, several older interpretations should be modified. For example, one author described the resonance dispute as being ideologically and politically the same phenomenon as the biological discussion, with the same result. He called the outcome "Lysenkoism in chemistry."⁵¹ Actually, the result of the resonance controversy was a defeat for Lysenkoism, in contrast to its victory in biology. The initial attack on the resonance theory was a manifestation of Lysenkoism, but the significant feature of the resonance controversy was that the chemists successfully defended themselves against the most serious attack. The modifications of theory were primarily terminological.

Gustav Wetter's short discussion of the resonance controversy also did not mention the central position of Chelintsev.⁵² Wetter indicated that the real source for the resonance controversy was central direction from above: "One gets the impression that at this period virtually everything was seized upon and correspondingly inflated, which could in any way offer a handle for convicting Western theories of 'idealism,' 'Machism,' etc.; just as the possibility of embracing Butlerov's theory offered a welcome opportunity for display of 'Soviet patriotism.'"⁵³

Rather than being a controversy initiated from above, it appears that the

⁴⁹ The author is grateful to Dr. Pauling for this information.

⁵⁰ *Ekonomicheskaya Gazeta*, March 26, 1962, p. 10.

⁵¹ Maxim Mikulak, "Postwar Soviet Attacks

on 'Bourgeois' Science, 1945-51," unpublished Russian Institute essay, Columbia University, 1952, p. 52.

⁵² Wetter, *op. cit.*, pp. 432-436.

⁵³ *Ibid.*, pp. 435-436.

resonance issue sprang up from below, nurtured and prompted by zealous, ambitious chemists who hoped to win party support in discrediting the scientists who utilized the resonance theory. This initiative probably embarrassed rather than pleased Soviet scientific administrators who did not want to harm the productivity of the chemists.

The majority of these chemists were willing to defend the tools necessary for the practice of their science, and the quantum-mechanical approach, condemned by Chelintsev, was one of these essential tools. Therefore, they decided to accept Chelintsev's diagnosis of the ideological disease in chemistry, but to reject his recommended cure. Without using the fictitious resonance structures, they would preserve the mathematical core of the theory, maintaining that such a solution was compatible with the dialectical-materialist approach to science and Butlerov's approach to chemistry. The solution to the dilemma was a delicate compromise that left no room for further shift back toward the theory of resonance without readopting it.

Very little has been said here in defense of the theory of resonance, although the Soviet criticisms have been described in considerable detail. Actually, the theory of resonance has already proven its usefulness in science, completely aside from the question of its truth. If the theory of resonance were replaced by a new theory tomorrow, the concept of resonance would have served a useful purpose. The originators of the theory have warned repeatedly that no physical significance should be assigned to the resonance structures, which are primarily helpful descriptions. The theory of resonance is a man-made system for organizing and understanding the complex data collected from chemical reactions—a system which bears a certain resemblance to the structure of a molecule but which definitely is not identical with that molecule.

Therefore, when the Soviet philosophers accuse the chemists in the West of describing molecules by means of intellectual structures, they are correct. But while the Soviets may consider this observation a condemnation, the Western scientists view it merely as an accurate description, not at all pejorative.

Teachers of the theory of resonance do have the obligation to remind their students that the theory is primarily an intellectual aid, and Wheland devoted quite a few pages to this point. Nevertheless, it is true that some chemists mistakenly think of resonance as a mechanical phenomenon.⁵⁴ However, Pauling and Wheland can hardly be blamed for misinterpretations of their theory. The use of the theory is neither required nor prohibited. Herein lies the greatest difference between the Western and Soviet attitudes toward resonance—in the Soviet Union the element of obligation has been present.

⁵⁴ For an example of such a misinterpretation of the resonance theory, see "On 'Non-resonance' Between East and West," *Chemical*

and Engineering News, June 16, 1952, 30: 2474, and the correction sent in by G. W. Wheland printed on p. 3160 of the same volume.