

and V. V. Orlov, *J. Exper. Theoret. Phys. USSR* **25**, 513 (1953)]

* This situation was considered in a discussion with V. I. Skobelkin.

¹D. I. Blokhintsev, *Doklady Akad. Nauk SSSR* **82**, 553 (1952)

²D. I. Blokhintsev and V. V. Orlov, *J. Exper. Theoret. Phys. USSR* **25**, 513 (1953)

³M. S. Svirski, *Vestn. (Moscow State University)* **3**, 43 (1951)

⁴A. Sommerfeld, *Ann. d. Phys.* **44**, 177 (1914)

The Problem of Obtaining a Metastable Modification of Thallium

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AN explanation as to the role played by the crystal lattice in the phenomenon of superconductivity may be found in various studies of the crystalline modification of one or another of the substances at low temperatures. In three well-known metals, thallium, titanium and zirconium, the α -modification exhibits superconductivity but β -modification has not been investigated at low temperatures.

One of the methods yielding a high temperature modification in metastable form is that of sudden quenching. This method of quenching pure substances has been treated by Sekito¹. In this work an x-ray investigation was made of the modification of thallium (prepared by Kal'baum) which had received rapid cooling of the metal in ice water. As is known, at 235°C, thallium undergoes allotropic changes in which the density due to hexagonal close packing changes to that of a body centered cubic². Due to this quenching¹ the sample now exhibits a face centered lattice structure.

We have undertaken a low temperature study of the metastable modification of thallium (99.98% pure). The desired quenching may be achieved by several methods:

1. Thallium melted in a glass tube over a Bunsen-burner and plunged into ice water (method of reference 1).

2. To avoid crystallization of melted thallium in the α -modification, stable at 0°C, the sample before quenching is slowly cooled in the oven from melting temperature (303°C) to 290°C. The sample is prepared by melting thallium in thin

walled capillary tubes having a wall thickness of 0.1 mm.

3. For very rapid quenching the melted thallium is poured out under vacuum on a copper surface cooled to the temperature of liquid air.

Immediately after the preparation of the sample, x-ray analysis followed. It appears that x-ray analysis does not reveal any difference between the quenched sample and that of ordinary thallium. This likewise applies to the measured magnetic moment of the samples at the liquid temperature of helium. In all samples, in quenched as well as in unquenched, the transition to the superconducting state was observed at 2.38-2.4°K. The marked absence of hysteresis (less than 1%) and the abrupt transition from superconductivity to the normal state is evidence of the absence of impurities occluded in the sample.

Analysis of the results of these methods shows that not one of the above methods lends itself to producing the thallium in metastable modification as in contrast of the statements found in reference 1. Thus the question of quenching pure thallium is left open.

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Translated by A. Andrews
42

¹S. Sekito, *Z. Krist* **74**, 189 (1930)

²H. Lipsona, A. R. Stoks. *Nature* **148**, 437 (1941)

Possible Methods of Obtaining Active Molecules for a Molecular Oscillator

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AS was shown in reference 1, one must use molecular beams in order to make a spectroscope with high resolving power. In this reference the possibility of constructing a molecular oscillator was investigated. Active molecules needed for self-excitation in the molecular oscillator were to be obtained by deflecting the molecular beam through inhomogeneous electric or magnetic fields. This method of obtaining active molecules has already been employed in the construction of a molecular oscillator²

There is yet another way of obtaining active molecules, namely, pre-exposure of the molecular beam to auxiliary high frequency fields which induce resonance transitions between different levels of the molecules. In Fig. 1 and Fig. 2 we illustrate the possible variants which utilize an exciting irradiation of frequency ν_{ex} for populating the upper level in order to obtain a scheme of self-excitation with the frequency ν_g .

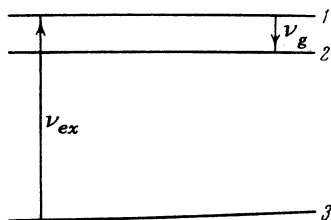


Fig. 1

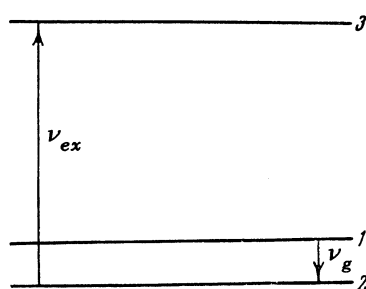


Fig. 2

In one case, illustrated by Fig. 1, active molecules in level 1 are obtained at the expense of molecules in level 3 through transitions induced by the high frequency field. If the high frequency field possesses sufficient energy, so that the effect nears saturation, then the number of active molecules equals

$$\frac{1}{2}(N_3 - N_1) + N_1 - N_2, \quad (1)$$

where N_i is the number in the i th level.

The number of active molecules in level 1 increases with an increase of the energy difference between the first and third level relative to the energy difference between the first and the second levels. One must consider that the number of molecules in the levels is determined, in the case of thermodynamic equilibrium, by the Boltzmann factor.

$$N_i \sim e^{-E_i/kT}, \quad (2)$$

where E_i is the energy of the i th level and T is the absolute temperature of the molecular beam.

These considerations are valid for the case illustrated in Fig. 2. Here, however, instead of an increase of the number of molecules in level 1, we have a decrease of the number in level 2. The number of active molecules equals, in this case,

$$\frac{1}{2}(N_2 - N_3) + N_1 - N_2. \quad (3)$$

The method presented herein can be used, for example, in the following cases.

1) Level 1 and 2 appear as neighboring rotational levels belonging to one and the same vibrational state of the molecule, with level 3 belonging to a neighboring vibrational state. In this case the rotational quantum number of this level (level 3) differs from that of level 1 and 2 by $\Delta J = 0, \pm 1$.

It is convenient to use the transitions between the vibrational levels for which $\Delta J = \pm 1$, since this case does not impose too strict a requirement for the exciting irradiation to be monochromatic. Since transitions between vibrational levels fall in the infra-red region of the spectrum for most molecules, the exciting irradiation must belong to this frequency range. However, infra-red thermal sources in existence at the present time have insufficient power to produce a saturation effect.

2) Levels 1, 2, and 3 are rotational levels of the molecule with asymmetric rotational momentum.

3) Levels 1 and 2 are hyperfine structures belonging to a given rotational state, and level 3 is a hyperfine level of a neighboring rotational level.

4) Levels 1 and 2 are specified by an inversion doublet belonging to a rotational level, and level 3 is one of the inversion levels of a neighboring rotational state.

The method presented here can be used to obtain a sufficient number of active molecules for the purpose of constructing a low frequency molecular oscillator.

Translated by A. Skumanich
41

¹ N. G. Basov and A. M. Prokhorov, J. Exper. Theoret. Phys. USSR 27, 282 (1954)

² C. N. Townes et al, Phys. Rev. 95, 282 (1954)

Luminescence of Organic Scintillators

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DESPITE a number of attempts in this direction, so far no satisfactory explanation has been offered for the low light energy output of organic