

# Yakov Ilich Frenkel

## Advanced



\*Feb. 10th 1894 in Russia

† 1952 Soviet Union

In giving a short biography of Yakov Ilich Frenkel, one can't do better than **Serguey L. Lopatniko** from the Center for Composite Materials, University of Delaware, and **Alexander H.-D. Cheng** from the Department of Civil Engineering, University of Mississippi. What follows are excerpts from their article in the *Journal of Engineering Mechanics*, ASCE, 2005.

The complete article may be found in this [Link](#)

If you ask a **physicist** from any country: "Have you heard about vacancies in crystals, quantum theory of conductivity, excitons, exchange interaction leading to spontaneous magnetization of the ferromagnetics and their domain structure?" He definitely will say: "Yes! These are basic physics. Everybody knows."

If you ask a **material scientist**: "Do you know that apparent stiffness of a metal is many orders lower than its theoretical value?" You will get the same answer: "Of course I know. It is a common knowledge."

If you ask a **chemist**: "What do you think about the definition of temperature for a single molecule?" He will answer: "Oh, it is one of the most important ideas in the theory of reaction of gases."

If you ask an **astronomer**: "Do you know that if a star has a mass slightly larger than our Sun, it can become unstable and collapse into a neutron star?" The astronomer will tell you: "Of course! It is basic astronomy."

If you ask a **geophysicist**: "Do you know that the Earth's magnetic field is mostly generated by the movement of electrically conducting liquid in the melted part of Earth mantle?" He will definitely say: "Sure, we all know that as the Earth's Dynamo."

However, if you ask a **western** scientist: "Who introduced all these ideas in science?" You will get, perhaps, many great names such as Dirac, Heisenberg, Pauli, Chandrasekhar, Bullard, among others.

It is improbable that somebody will give you the answer: one person introduced all these ideas—the brilliant Russian scientist **Yakov Il'ich Frenkel**.

**Yakov Frenkel** was born on **February 10, 1894** in the southern Russian city **Rostov-on-Don** (to Jewish parents). Since his early years he showed a talent in music, fine arts, and science. Being a student in the May Gymnasium at St. Petersburg, Ya. Frenkel wrote a 100-page mathematical paper, which was sent to Jacob Viktorovich Uspenskii, then a student of the famous Andrei Andreyevich Markov, for comment. Uspenskii found that the young Frenkel had rediscovered many results of the calculus of finite differences, which was not a part of his Gymnasium education.

Right after the Revolution, in 1918, Frenkel left St. Petersburg and took part in the organization of Tavrichesky University in Yalta, Crimea.

Living conditions in Crimea at that time were terrible. Excellent climate of Crimea could not compensate for the deprivation of war and hunger. Professor of the University was rationed 200 grams (less than ½ pound) of bread per day and a "free lunch"—one plate of "kasha." Frenkel was jailed for two months during that time for political reasons. His younger brother Sergei, also a brilliant scientist, was drafted by the army and was killed in an accident. It was devastating for Frenkel and his family because of the five Frenkel siblings, only two remained alive.

In **1926** Frenkel introduced the key idea of defects of crystalline structure. He showed that the "evaporation" of atoms (or ions) from their equilibrium states occurred under finite temperature and introduced the idea of moving holes that could propagate through crystals independent of the movement of the atom that left it. These defects are known as **Frenkel defects**. On the base of this idea he calculated the electric conductivity of ion crystal and developed the theory of vibrational-translational movement of molecules in liquids and amorphous bodies, and particularly the theory of diffusion and viscosity of liquids and amorphous bodies.

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- In **1945**, the 220th anniversary of the Academy of Sciences was held, which was also an occasion to celebrate the returning to peace and the reconnection of the Russian scientific community with the international community.
- Frenkel was able to meet a number of old friends, including F. Joliot-Curie, I. Langmuir, and M. Born. During the sessions Frenkel was honored, along with other scientists, with the Labor Red Banner Order. Two years later, his Kinetic Theory of Liquids was awarded the First Grade State Prize.
  - However, even at that time there existed the first hint of a change in the socialism policy; and the first gust of cold wind reached Frenkel soon after the anniversary. The ensuing political persecution affected not only Frenkel, but also many other prominent scientists. Frenkel's work was criticized for not contributing to the construction of the society of great socialism. His contributions in quantum mechanics and the theory of relativity were labeled as servility to Western science. His publications in the Western journals were unpatriotic. Several of his best books were published in German and English before they became available in Russian. To his accuser, these testified that Frenkel was in a hurry "to help the Americans use the achievements of Soviet Science in the interest of monopolistic capitalism."
  - He was even accused by his colleagues and the director of the Institute that his use of terms like "forced collectivization of electrons" and "collectivization under pressure" was a derision of soviet collective farms.
  - Frenkel's work was greatly affected and his health deteriorated toward the end of his life. He died in **1952**, not quite **58** years old.
- Use the [Link](#) and read the whole article! It's worth it - not just for learning about Frenkel's achievements, but also for learning soemthing about the not-so-remote past.