Shubnikov: A case of non-recognition in superconductivity research

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Despite the fact that L. V. Shubnikov made outstanding contribution to the discovery of high field or type-II superconducting alloys in mid-1930s over and above his other important contributions to low temperature physics, he has almost been universally ignored. We describe a short account of his scientific activities in superconductivity research and its socio-political context of the 2nd quarter of the 20th century. We also discuss probable reasons of oblivion of Shubnikov.

Instances of non-recognition and non-citation of earlier important work are not rare. Recently, Sharma and Sen[1] have reported such a case in the history of superconductivity research. Another spectacular case is that of the papers by Shubnikov and collaborators published during 1934–1937.

Lev Vasil'evich Shubnikov was born on 29 September 1901. He has been claimed[2] as 'the founding father of Soviet low-temperature physics'. A list of 48 scientific publications of Shubnikov and collaborators between 1924 and 1937 was given by Alekseevskii[2] and Balabekyan[3]. The list may not be an exhaustive one – three papers (one paper[4] on superconductivity and two short communications[5,6] on 'neutron absorption in metals at low temperature') were missing in the list.

Shubnikov was trained in low temperature physics research in the University of Leiden, Holland during 1926–1930 under Wonder Johannes de Haas. His reputation as a good experimentalist was established by his work in Leiden (Shubnikov-de Haas effect)[7]. Already during his student days (1922–1926) in Leningrad Physico-Technical Institute (LPTI) he worked as an assistant to Ivan V. Obreimov and did valuable research work. Work of this period included a method of producing single crystal from molten metal (Obreimov–Shubnikov method). He developed 'an optical method for study of elastic and residual deformations in crystals' (his thesis work at LPTI).

After his return from Leiden in late-1930, Shubnikov joined Ukrainian Physico-Technical Institute (UPTI), Kharkov. His mentor of LPTI days, Obreimov was then UPTI's director. He was establishing a cryogenic laboratory. Shubnikov joined him and in 1931 was given the charge of scientific director of this laboratory. Shubnikov's wife Ol'ga Nikolaevna Trapeznikova was also a physicist. She was one year junior to Shubnikov at LPTI. Shubnikov was the only student with physics major in his class. He was asked to attend classes with his one year seniors and one year juniors. So, Shubnikov and Trapeznikova attended classes together and came to know each other. They were married in 1925. Trapeznikova accompanied him to Leiden. She was Shubnikov's research collaborator in the work on thermal and magnetic properties of transition metal chlorides which led to the experimental discovery of antiferromagnetism. There is no reference of Trapeznikova's participation in superconductivity research.

Shubnikov and collaborators investigated in detail the magnetic properties of superconducting metals and alloys. They also studied the special features of destruction of superconductivity in simple metals, alloys and a tin ring by high current and magnetic fields in them. Shubnikov and collaborators observed[4] high field (now known as type-II) superconductivity in single–phase, single crystal lead–thallium ($PbTl_2$) and lead–indium (Pb–In) alloys in 1937. They observed[8] many of its features as early as in 1935. This was some twenty-five years before the experiment of Kunzler and collaborators[9] demonstrating type-II superconductivity in niobium–tin (Nb_3Sn) alloy. Moreover, Shubnikov and collaborators discovered high field superconductivity at a time when low current carrying capacity was upsetting any possible technological application of superconductivity. Their contribution was almost universally ignored, not only in Europe, but also even in the Soviet Union. He received some attention after 1957 when another Russian physicist Abrikosov compared his theory of type-II superconductivity[10] with the experimental data of Shubnikov[4].

The work of Shubnikov was apparently well known in Europe before the Second World War via monographs of Ruhemann and Ruhemann[11] and Shoenberg[12]. Martin Ruhemann was in Kharkov during 1932–1938 and thus was familiar with the work of Shubnikov and collaborators. Shoenberg cited explicitly the work of Shubnikov and collaborators. His work was also familiar particularly in England where a number of cryogenicists had taken refuge[13]. It is on record that Dutch low temperature physicists had contact with him. Pyotr Leonidovich Kapitza knew about Shubnikov's work and visited UPTI more than once when he was in Cambridge (1921–1934). Indeed Kapitza during his Cambridge days was always in touch with the Soviet physics and regularly visited Soviet laboratories as consultant.

In the purging phase of late-1930s, Shubnikov was arrested[13] on 6 August 1937 on allegation for anti-state activities. Within three months after his arrest he had been sentenced[14] to 'ten years imprisonment without right to correspondence' on 28 October 1937. He died in prison, but there was confusion about the manner and date of his death[13–15]. Trapeznikova mentions that after repeated appealing, she received in 1957 a communication from the authorities declaring that Shubnikov died of heart failure on 8 November 1945 (as reported by Ranyuk and Freiman[15]). Rotter[14] (as reported by Ranyuk and Freiman[15]) states that in fact within twelve days of solitary confinement Shubnikov was executed by a firing squad on 10 November 1937. Finally, Shubnikov[13] was exonerated posthumously by the Military Board of the Supreme Court of Soviet Union on 11 June 1957. It is now accepted within and outside Russia that Shubnikov was killed in November 1937. In 2001, the year of his birth centenary, a special issue of Russian journal *Fizika Nizkikh Temperatur* (Low Temperature Physics) was devoted to memory of Shubnikov, which mentions[16] the year of birth and death of Shubnikov as 1901 and 1937 respectively.

In a short period between August 1937 and April 1938 many other top-talented scientists were arrested and sentenced in various manners[13]. They included Igor Yevgenyevich Tamn (one of the first Soviet Nobel Prize winners), Ivan V. Obreimov, A. I. Leupunski, Moissey A. Koretz, Yuri B. Rumer, Lev Davidovich Landau and some others (most of them from Kharkov). Koretz and Rumer were Landau's students and co-workers. They were arrested[17] together with Landau on 28 April 1938. Vladimir A. Fock the well-known theoretical physicist from Leningrad and Alexander Weissberg, an Austrian scientist working at Kharkov were also arrested. There were some German Jewish physicists at Kharkov institute who fled from the Nazi Germany. From different records it is now known that Kapitza tried his best to save and free Landau. He was successful. But history is silent if Kapitza utilized his influence to save any other physicist like Shubnikov. In one letter[13] to Joseph Stalin, Kapitza bracketed Landau's name with Fock's as the 'most eminent theorist in the Soviet Union'. Many of the arrested scientists were released after various terms of rigorous imprisonment (e.g. Koretz spent 20 years in the prison of Gulag, Rumer spent 10 years in *Sharashka* – a scientific and engineering institution run like a prison)[17]; but others were cast into oblivion. The whole story may never be unearthed and told.

The list of scientific publications[2–6] of Shubnikov revealed three stages of his research activities. The first stage was during 1924–1926 in Leningrad; he published two papers in *Zeitschrift fur Physik*. The second stage was in Leiden during 1926–1930; it resulted in eight publications with de Haas as collaborator, six published in the *Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam* and one each in *Nature* (*London*) and *Physica* (*Amsterdam*). The final stage was in Kharkov during 1930–1937. In this period he has no publication until 1934. The cryogenic laboratory at Kharkov was just beginning. The helium liquefier came from Holland and the system was ready for experiment only in late-1933. During 1934–1937 he published 41 papers out of which 18 were on superconductivity. These papers were published in the issues of the *Physikalische Zeitschrift der Sowjetunion* in German language, *Zhurnal Eksperimental'noi I Teoreticheskoi Fiziki* and *Zhurnal Tekhnicheskoi Fiziki* in Russian language. Abridged forms of these papers or portions were also published in *Nature* (*London*) as short communications.

Berlincourt[18] has discussed the work of Shubnikov on superconductivity in some detail and speculated about the case of non-recognition of his contribution by later investigators. According to him, Shubnikov did crucial experiments and interpreted them correctly which could favour theories of C. J. Gorter and H. London and could rule out sponge model of Mendelssohn. But Shubnikov did not mention Gorter, London or Mendelssohn in 1935. He had no scope to do so later. Gorter or London on their part failed to take support from his excellent experimental data. Mendelssohn on the other hand maintained the view[19] that Shubnikov's 'series of superb experiments came to an abrupt end without allowing him time to give an interpretation of his observation'. Berlincourt reported[18] that 'Keesom and Desirant (1941) noted the inapplicability of thermodynamics based on complete flux exclusion (of a type-II superconductor); they made no mention of any possible relation of their results to the predictions of Shubnikov *et al.* (1934)'. Their results were in agreement with the predictions of Shubnikov and collaborators.

The *Web of Science* (*WoS*) database now provides citation profile of items published since 1900. The twelve papers and six short communications on superconductivity by Shubnikov and collaborators published between 1934 and 1937 are found to have received meagre citation. Altogether 15 citations are associated with short communications whereas the longer twelve papers are found to have no citation in *WoS*. Among these 15 citations for short communication, 13 are for the paper published in *Nature*[8]. However, most of these 13 citations are after 1960 (after the work of Kunzler[9]).

Lack of timely recognition is unfortunate for healthy progress of science. Science is global; scientists from any part of the globe (in principle) can contribute. However, there is a 'court of justice' in scientific matters primarily populated by the peers and authorities in every field of study in science. Such 'courts of justice' occur in scientifically developed centers in certain core countries. Over the last 200 years these were Western European countries, later on joined by USA and Japan. It is difficult to get recognition for scientists beyond these core areas. Even when the scientists from the periphery work in collaboration with the scientists in the 'core', or in the establishments of the 'core', recognition may not be forthcoming.

In Shubnikov's time, the Soviet Union was beyond the core area. Although Shubnikov was not unknown to scientists in the core, he was not sufficiently visible. Soon after 1937 the Second World War started. It should also be noted that during the war and for sometime afterwards superconductivity was not a favourable and supported area of research. Shubnikov was forgotten completely in his own country, as he was a condemned person for 20 years from 28 October 1937 to 11 June 1957. During these two decades, no Soviet scientist was allowed to cite his work. Abrikosov mentioned his work only in late-June of 1957.

Some scientists from the periphery, sometimes feel extremely bitter about the neglect and non-recognition by the officialdom of science. E. C. G. Sudarshan called this officialdom or 'court of justice' as ruled by robber barons[20].

All such factors probably contributed to oblivion of Shubnikov for a long time. Attempts should be made to identify any case of omission in recognizing a significant contribution as early as possible for bestowing appropriate tokens of recognition. Will it be possible to develop a system or mechanism for such identification?

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