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**Fundamental meaning of superconductivity: a historical perspective  
for 100<sup>th</sup> anniversary of superconductivity and 25<sup>th</sup> of hi- $T_c$**

JÓZEF SPAŁEK

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Superconducting and superfluid states represent the ideal examples of *condensed quantum macro state*. This feature will be illustrated by discussing first their nontrivial fundamental properties followed by the description of their quantum and classical aspects: classical character of the transition at  $T_S > 0$ , as well as *quantum critical character in unconventional superconductors* for  $T_S = 0$  and at the border of onset of magnetism. The second part will be concerned with a non-intuitive character of the *superconducting order parameter*, emphasizing its connection with the so-called *macroscopic wave function*, and its appearance together with the breakdown of *gauge symmetry*. In the last part (and throughout the talk) I will illustrate the difficult questions related to the unexplained experimental results and concepts for *high- $T_c$*  and *heavy fermion systems*. The aim of the talk is mainly didactical. Therefore, some basic questions, which are difficult to answer, will be posed, but not necessarily fully answered.

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