Altermagnetism and spintronics without magnetization and relativity

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Magnetically ordered crystals are traditionally divided into two elementary phases – ferromagnetism and antiferromagnetism. In the first part of the talk, we will recall that the ferromagnetic order offers a range of phenomena for energy efficient IT, while the vanishing net magnetization in antiferromagnets opens a possibility of a breakthrough towards a new-generation IT with ultra-high capacity and speed [1-3]. In the second part of the talk we will move on to the recent predictions of instances of strong time-reversal symmetry breaking and spin splitting in electronic bands, typical of ferromagnetism, in crystals with antiparallel compensated magnetic order, typical of antiferromagnetism [4-6]. This apparent fundamental conflict in magnetism is resolved by symmetry considerations that allow us to classify and describe a third elementary magnetic phase [7]. Its alternating spin polarizations in both crystal-structure real space and electronic-structure momentum space suggest a term altermagnetism. We will demonstrate that altermagnets combine merits of ferromagnets and antiferromagnets, that were regarded as principally incompatible, and have merits unparalleled in either of the two traditional basic magnetic phases. We will introduce the broad materials landscape of altermagnetism and show how its unconventional nature enriches fundamental concepts in condensed matter physics [6,7]. We will show that this underpins a development of a new avenue in spintronics, elusive within the two traditional magnetic phases, based on strong non-relativistic spin-conserving phenomena, without magnetization imposed scalability limitations [1-9].

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