Altermagnetism — A New Punch Line of Fundamental Magnetism

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Abstract: “Non sunt multiplicanda entia sine necessitate", entities should not be multiplied without necessity. This observation made by the Franciscan monk John Punch in 1639 still resonates with modern philosophies: new terminology should only be introduced into papers when it advances understanding. Since many years, the canonical classification of ordered magnets included noncollinear (with many further subdivisions) and two collinear types: antiferromagnets (AF), which have net magnetization zero by symmetry, and ferro/ferrimagnets (FM), which do not have this property. The two have distinctly different micro- and macroscopic properties. It was supposed, for instance, that only FM can exhibit spin-splitting of the electronic bands in absence of spin-orbit coupling AND lack of inversion symmetry, have anomalous Hall effect (i.e., Hall effect driven by variation of the Berry phase), magnetooptical effects, suppressed Andreev scattering in contact with a singlet superconductor etc. A surprisingly recent development (~2019) is that this classification is incomplete: there are collinear magnets that would belong to AF by this classification, but show all characteristics of FM, except the net spin polarization! They were recently dubbed "altermagnets", AM. Incidentally, what has also not been fully appreciated was that there are also materials that have strictly zero net magnetization, but enforced not by symmetry, but by the Luttinger's theorem, and therefore truly belonging to the FM class ("Luttinger-compensated ferrimagnets"). In this talk I will present the new classification and explain, in specific examples, what are the symmetry conditions for AM, why these are a truly new class deserving a new name, and how their unusual properties appear, and why they are such a fashionable subject now.

Bio: Prof. Igor Mazin received his M.Sc. in Metal Physics from the Moscow Institute for Steel and Alloys in 1977 and his Ph.D. in Theoretical Physics from the P.N. Lebedev Physical Institute in 1984. Before joining George Mason University in 2019, he held research positions at the Lebedev Physical Institute, the Max Planck Institute for Solid State Research, the Carnegie Institution of Washington, and the U.S. Naval Research Laboratory. Prof. Mazin is internationally recognized for his pioneering theoretical work on superconductivity and electronic structure in complex materials. His numerous honors include the USSR Prize for Young Scientists, the John Bardeen Prize, the Heraeus Research Award, and repeated inclusion in the Clarivate Analytics Highly Cited Researchers list. He has authored over 350 publications with more than 24,000 citations and serves on the editorial boards of Physical Review X and npj Quantum Materials.