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Preface

Difference of opinion leads to enquiry, and enquiry to truth.
Thomas Jefferson to P.H. Wendover

The discovery of superconductivity in layered FeAs materials [1] is a vivid example of the surprises inherent in the field of superconductivity. Because iron is strongly magnetic and rarely forms superconducting compounds, it would seem to be an unlikely component of a high-T_c superconductor. Nonetheless, some of the iron-pnictides have superconducting transition temperatures, ∼55 K, far surpassing those of all known intermetallic compounds. The non-superconducting stoichiometric parent compounds of FeAs-based superconductors are antiferromagnetic. Some also have strong magnetic moments at low temperatures. When antiferromagnetism is suppressed, by doping or by pressure, it is replaced by superconductivity in a fashion reminiscent of the replacement of antiferromagnetism by superconductivity in the cuprate high-T_c superconductors. The electronic structure suggests that the same magnetic interactions that drive the antiferromagnetic ordering also produce the pairing interaction for electrons. If so, theory suggests that the superconducting order parameter should have different signs on different Fermi surface pockets. A number of experiments support this scenario, while others are harder to reconcile with it. Thus, the jury is still out on whether magnetism is a nuisance or a driving force with respect to superconductivity.

One of the key issues is how strong the correlations are in these systems and whether magnetism (and by implication, superconductivity) is mostly itinerant and long-range or localized and short-range. While theorists are proposing one picture or the other, experimental results are just beginning to trickle in.

The iron-pnictides demonstrate the fascinating physics that emerges from the delicate interplay of competing ground states. Understanding them may open new avenues for other novel classes of superconductors with desirable technological properties such as low anisotropy. While the cuprates may be the first demonstration of unconventional high-temperature superconductivity, this latest discovery shows that many other novel families of materials are waiting to be discovered.

This invited review issue of Physica C follows the tradition of an earlier edition focusing on MgB_2 [2]. Barely a year has passed since the original discovery [1] and in that time the combination of impressive experimental and theoretical efforts has yielded rapid progress towards understanding these new materials. The papers in this issue provide comprehensive reviews of the current state of the art including new information about materials synthesis, experimental properties, and theoretical explanations and predictions for this fascinating new class of materials.

References

[1] Y. Kamihara, T. Watanabe, M. Hirano, H. Hosono, J. Am. Chem. Soc. 130 (2008) 3296.

[2] Superconductivity in MgB_2: electrons, phonons and vortices, Physica C 385 (2003) 1–2.

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