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Preface

Special issue on pressure-induced superconductivity in CrAs and MnP

Guest Editors

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Transition-metal monopnictides, CrAs and MnP, are helimagnetic metals with intriguing magnetic and electrical properties that have been known since over fifty years ago. Very recently, superconductivity (SC) was observed to emerge in the vicinity of the pressure-induced helimagnetic quantum critical point for both compounds, making them the first superconductors among Cr- and Mn-based compounds, respectively. These discoveries, in particular the close proximity of SC to the helimagnetic order reminiscent of many unconventional superconducting systems, have aroused considerable attention in the community of SC. In this special issue, we review the recent progress on the pressure-induced SC in CrAs and MnP [1] and collect some new developments for understanding the peculiar properties of these two compounds.

Although both CrAs and MnP are 'old' magnetic materials, many of their magnetic and electrical properties at ambient pressure remain poorly understood. The discovery of pressure-induced SC in both compounds generates several 'new' issues that need to be properly addressed. In the Topical Review [1], we try to provide a comprehensive overview covering both the 'old' and the 'new' problems for these two compounds. For each section on CrAs and MnP, we start with a brief introduction on the structural and physical properties at ambient pressure and restate the unresolved intriguing issues. After presenting the discovery of pressure-induced SC, we provide a detailed summary on the recent follow-up studies pertinent to the observed SC. Finally, we list some open issues and perspectives on the future research directions for both compounds.

There are two papers related to CrAs in this special issue. In an experimental study by Kotegawa *et al* [2], they first investigate the influences of the crystal growth procedures on the observed SC in CrAs, and then elucidate the microscopic electronic state at the phase boundary between the helimagnetic and the paramagnetic phases by using the nuclear quadrupole resonance (NQR) technique. Although the presence of quantum critical point is not favored due to the strong first-order nature of the helimagnetic transition, strong spin fluctuations are observed in the paramagnetic phase, thus highlighting the importance of spin fluctuations for mediating the Cooper pairing in the vicinity of the first-order magnetic transition in CrAs. Theoretically, Autieri *et al* [3] evaluate the electronic band structure of CrAs via combining the tight-binding approximation and the Lowdin down-folding procedure. They not only derive an effective Hamiltonian model describing the Cr-3d bands near the Fermi level, but also calculate the Fermi surfaces and the physical properties in good agreement with the available experimental data. Thus, the present theoretical study should provide a reasonable starting point for further theoretical developments on CrAs.

Since the magnetic structures of MnP under high pressures are under debate at present, two papers in this special issue are dedicated to settling this controversial issue. Both an experimental investigation with muon-spin rotation (uSR) by Khasanov *et al* [4] and a theoretical study by Xu *et al* [5] are consistent with a change of the propagation vector for the helical states from $\boldsymbol{Q}//c$ at low pressure to $\boldsymbol{Q}//b$ at high pressure. In addition, the refined magnetic structure for the low-temperature and low-pressure helimagnetic state with $\boldsymbol{Q}//c$ is also obtained via analysis of the uSR data. Interestingly, the first-principles calculations by Xu *et al* [5] further reveal the coexistence of the quasi-1D charge carriers, which appear in the ferromagnetic state and become gapped in the spiral state, and the anisotropic 3D charge carriers. Such a two-fluid behavior should arise from the peculiar crystal structure of MnP. In order to further clarify the structural evolution of MnP under high pressure, Yu *et al* [6] perform *in situ* angle-dispersive synchrotron x-ray diffraction on MnP crystal up to 40 GPa. Their results demonstrate that MnP undergoes a pressure-induced structure transition at about 15 GPa. Although the high-pressure structure cannot be readily indexed experimentally, some plausible structural phases are predicted by *an initio* calculations in the same study.

We hope that the articles in this special issue can help interested readers to catch up on the rapidly growing progress regarding pressure-induced SC in CrAs and MnP. We thank the authors for their contributions to this special issue and the editorial staff of JPCM for their efficient handling of the manuscript.

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