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Structural tuning of superconductivity and magnetism in intermetallic iron-pnictide materials[1]

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The relationship between superconductivity, magnetism and crystallographic structure remains as one of the intriguing properties of the new family of iron-based superconducting materials. A well established requirement for high-temperature superconductivity in these systems is a substructure of iron ions tetrahedrally coordinated with either pnictogen or chalcogen anions stacked together to form a layered material, suggesting that both tetrahedral geometry and quasi-two-dimensionality are key ingredients. Through an investigation of solid solutions of (Ba,Sr,Ca)Fe_2As_2 series of parent compounds, we present a study of the importance of internal tetrahedral structure in stabilizing both magnetic and superconducting ground states in these materials, revealing an intimate relationship between the energy scale that dictates magnetic order and the internal structure of the $FeAs_4$ tetrahedra even far above the magnetic ordering temperature. In addition, interlayer coupling is investigated by exploiting the "collapse" of the tetragonal unit cell of $CaFe_2As_2$ under pressure, where interlayer pnictogen-pnictigen bonding changes dramatically. We investigate the effect of this collapse on superconductivity via chemical substitution, demonstrating an intriguing interplay of structure, magnetic and superconducting properties.

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