A new perspective on cluster ferromagentism

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One of the fundamental tasks of cluster science is to elucidate the evolution of condensed matter properties. One fruitful direction has been to measure magnetic and electric deflections of cluster beams in high vacuum. These beams are composed of neutral clusters that are produced in a well-controlled thermal environment and measured using position sensitive, high-resolution mass spectrometry methods. Experiments along these lines have produced a host of results that have had a significant impact on cluster science. Already in the early 1990's, measurements using these techniques have allowed a systematic study of ferromagnetism in the 3D transition metal clusters, Fe, Co and Ni [1]. These measurements showed that ferromagnetism is already recognizable in the smallest clusters and rather rapidly evolves to its bulk-like manifestation.
Early interpretations of this evolution concentrated primarily on the specific role of surfaces. In contrast, more recent measurements have clearly identified two ferromagnetic states that merge into a single state as the cluster size increases. These effects are seen clusters of the ferromagnetic metals as well as in clusters of the anti-ferromagnetic metals Cr, and Mn. These observations indicate that the evolution to bulk itinerant magnetism in general involves the development of a degeneracy of two ferromagnetic states with increasing size.
In this talk, I will review these results, and, time permitting, also address some intriguing recent results on the electric and magnetic deflections of Cu, Ag, and Au clusters.

[1] *Magnetism from the Atom to the Bulk in Iron, Cobalt and Nickel clusters*, I. Billas, A. Chatelain, W. A. de Heer, *Science* **265**, 1682, (1994)