A quarter-century of metal-cluster-beam physics, from the discovery of electronic shell structure to quantized ferromagnetism to cluster ferroelectricity.

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In the Fall of 1983, 25 years ago the first of a series of cluster beam experiments were performed that demonstrated electronic shell structure in sodium clusters. I will give a brief historical overview of these exciting times.

The order provided by the electronic shell model for clusters [1,2] departed radically from the prevailing models: small metal clusters were considered to be molecules, each one had its own identity and there was no reason to expect a systematic order in their properties.

The experimental discovery [1] was followed by years of debate. Electronic shell structure was often incorrectly equated with the spherical jellium model (which treats lithium and gold identically), leading to widespread and lasting confusion.

The electronic shell model (recently renamed the "superatom" model) has now become the prevailing paradigm for the basic electronic structure of diverse metal cluster systems over a wide range of sizes. Yet, why electronic shell structure is a ubiquitous phenomenon in a wide variety of metal cluster systems is still not fully understood.

The early experiments in Berkeley laid a foundation for other directions in cluster physics [3]. I will discuss recent Stern-Gerlach experiments on ferromagnetic clusters [4] including unpublished results on magnetism of Co and Fe clusters in excited states, with important implications for nanomagnetism, including a resolution of the longstanding spin-relaxation problem in free metal clusters [5].

I will further discuss new results [6] on the recently discovered ferroelectric state in low-temperature niobium and niobium alloy clusters with its possible connection to superconductivity [7]. This unusual state is characterized by a phase transition from a normal state to one with exceptionally large electronic dipole moments that exhibit a very large even-odd effect.

Finally, I will present new high-resolution polarizability measurements on sodium clusters as well as their electric dipole moments that are orders of magnitude smaller than predicted.

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[7] ***Nonclassical dipoles in cold Niobium clusters,***
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