Transitional Bonding in Colloidal Systems

Scientific Achievement
The discovery of a new type of bonding in colloidal systems where nanoparticles diffuse and hold together colloidal crystals in the same way electrons do in metallic bonding.

Significance and Impact
Numerous compounds have been devised with DNA-functionalized nanoparticles following design rules akin to ionic crystals, where individual colloids behave as programmable atom equivalents (PAEs) in superlattices. This electron-atom-equivalent duality lays the foundation to explore colloidal metallic alloy analogues.

Research Details
- We show PAEs that behave as electron-equivalents (EEs) when their sizes and DNA grafting density are reduced.
- In mixtures with large PAEs, the EEs roam the crystal as electrons in metals holding the large PAEs in specific lattices sites, akin to electron clouds in atomic metals.
- As the number of DNA strands increases or the temperature decreases, the EEs localize yielding a transition from metal to compound.

Work was performed at Northwestern University.

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