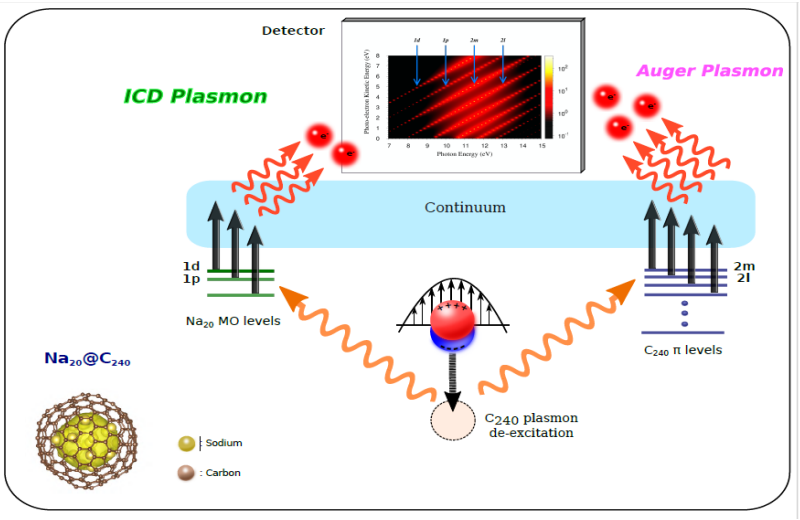
Buckyball giant-resonance transmits large-scale energy to adjacent metal-cluster

Research predicts an efficient transfer of energy from the buckyball that can stimulate “cold” electrons of a sodium cluster caged in it.

Rasheed et al., Phys. Rev. Lett. 130, 233201 (2023)



Fullerenes, or buckyballs, are fascinating molecules of carbon atoms having near-spherical structures like a soccer ball. The most popular form of fullerene is C_{60} with 60 carbon atoms forming a spherical cage-like shape. However, spherical fullerenes with varying number of carbon atoms are also abundant. The inside cavity of a fullerene can be doped by atoms, molecules, or clusters. Such doped fullerenes, known as the endohedral fullerenes, have been the subject of intense research since last few decades. The trapped species inherits certain features of the surrounding cage, especially when such systems are exposed to electromagnetic radiation. Our recent work published in Phys. Rev. Lett. focuses on this aspect of interaction with light when a cluster of 20 Na atoms is trapped inside a giant buckyball C_{240}.

The oscillating electro-magnetic field of extreme ultraviolet (XUV) light can set up a group oscillation of quasi-free electrons in a buckyball. This group-motion, known as the collective oscillation, leads to the formation of a giant resonance that can be probed by detecting torrents of electrons leaving the molecule. On the other hand, an XUV light cannot excite the quasi-free electrons in a Na cluster. However, the situation is different when a Na cluster is trapped inside C_{240}. Our simulations find an efficient transfer of energy from the buckyball to the caged cluster, instigating a group-motion in cluster electrons of Na_{20} as well. As a result, the ionization spectra have a significant contribution from the Na20 cluster, as found in the research and schematically shown in the illustration. The process leads to a new

mechanism of large-scale energy transfer between systems that can support group motions. The discovery paves a way to drive and control events at remote sites from a primary energy center.