A Discrete Model for Toroidal Moments and Its Realization

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A class of resonant modes with intrinsic toroidal moment is theoretically identified and experimentally realized in a discrete model, which is independent of the electric and magnetic moments. As an example, an antennas' system with inversion symmetry is analyzed systematically. The toroidal dipole resonances can be directly observed from the measured field profiles, agreeing well with the simulations. An eigenmode analysis are developed and this method can give a complete description for this system. This model is further generalized to a plasmonic-particles' system. The resonant toroidal moments in such simple electromagnetic systems may open up new avenues in both physics and applications for the emerging concept of toroidal moments.