Photonic Time-Crystals and Light-Matter Interactions Therein

Prof. Mordechai (Moti) Segev

Technion, Israel Institute of Technology

Photonic Time Crystals (PTCs) are dielectric media whose refractive index is strongly modulated periodically in time at time scales shorter than a single optical cycle. These systems conserve momentum but not energy, and are characterized by momentum bands and bandgaps where the amplitudes of their eigenmodes can increase or decrease exponentially.

The fundamentals of PTCs will be introduced along with the classical and quantum features of light-matter interactions in PTCs. Among these, the most notable is the emission of light in PTCs, which opens new avenues for making widely tunable lasers that do not rely on any atomic resonance and draw their energy from the temporal modulation of the medium. Another important feature is the quantum aspects, which yield a plethora of fundamental features ranging from the generation of pairs of entangled photons, controlling spontaneous emission through the temporal modulation, and creating 2D cluster states.

Finally, recent experimental progress on modulation shorter than a single cycle will be presented, focusing on the recent breakthrough of observing time-reflection at optical frequencies. Last but not least, nonlinear optics in such time-varying media will be discussed, envisioning new mechanism for high harmonic generation in solids that can yield large photon flux.