ABSTRACT 1

Disruption of the head direction cell network impairs the parahippocampal grid cell signal

Shawn S. Winter, Benjamin J. Clark, Jeffrey S. Taube

Navigation depends on multiple neural systems that encode the moment-to-moment changes in an animal's direction and location in space. These include head direction (HD) cells representing the orientation of the head and grid cells that fire at multiple locations, forming a repeating hexagonal grid pattern. Computational models hypothesize that generation of the grid cell signal relies upon HD information that ascends to the hippocampal network via the anterior thalamic nuclei (ATN). We inactivated or lesioned the ATN and subsequently recorded single units in the entorhinal cortex and parasubiculum. ATN manipulation significantly disrupted grid and HD cell characteristics while sparing theta rhythmicity in these regions. These results indicate that the HD signal via the ATN is necessary for the generation and function of grid cell activity.

ABSTRACT 2

Cycles of species replacement emerge from locally induced maternal effects on offspring behavior in a passerine bird

Renée A. Duckworth, Virginia Belloni, Samantha R. Anderson

An important question in ecology is how mechanistic processes occurring among individuals drive large-scale patterns of community formation and change. Here we show that in two species of bluebirds, cycles of replacement of one by the other emerge as an indirect consequence of maternal influence on offspring behavior in response to local resource availability. Sampling across broad temporal and spatial scales, we found that western bluebirds, the more competitive species, bias the birth order of offspring by sex in a way that influences offspring aggression and dispersal, setting the stage for rapid increases in population density that ultimately result in the replacement of their sister species. Our results provide insight into how predictable community dynamics can occur despite the contingency of local behavioral interactions.

ABSTRACT 3

Spatially structured photons that travel in free space slower than the speed of light

Daniel Giovannini, Jacquiline Romero, Václav Potoček, Gergely Ferenczi, Fiona Speirits, Stephen M. Barnett, Daniele Faccio, Miles J. Padgett

That the speed of light in free space is constant is a cornerstone of modern physics. However, light beams have finite transverse size, which leads to a modification of their wave vectors resulting in a change to their phase and group velocities. We study the group velocity of single photons by measuring a change in their arrival time that results from changing the beam's transverse spatial structure. Using time-correlated photon pairs, we show a reduction in the group velocity of photons in both a Bessel beam and photons in a focused Gaussian beam. In both cases, the delay is several micrometers over a propagation distance of ~1 meter. Our work highlights that, even in free space, the invariance of the speed of light only applies to plane waves.