



Contribution ID: 141

Type: **Contributed Oral**

Nonlinear wave dynamics on a chip

Friday 5 December 2025 11:10 (15 minutes)

Dissipative solitons and localized dissipative structures are ubiquitous, from optomechanics [1] to fluid dynamics [2], and even cosmological defects [3]. Dissipative solitons exist in systems far from equilibrium, where energy is continuously being lost and resupplied, which introduces unique properties distinct from analogous systems at equilibrium. These dynamics have been studied extensively in classical systems in wave flumes that are hundreds of metres long [4]; however, in addition to being extremely cost and labour-intensive, these systems still cannot span the entire nonlinear parameter space. We have engineered an optomechanical platform called a wave flume that, combined with nanometre-thick films of superfluid helium, can achieve high nonlinearity and form nonlinear dissipative systems capable of supporting dissipative solitons in several regimes [5]. In this work, we have demonstrated the ability to drive the system such that a single dissipative soliton is produced and locked in position among the fundamental mode of the superfluid third sound wave. Using cavity optomechanics, we are able to couple an optical field to the third sound waves of superfluid helium. Here, the photonic crystal cavity acts not only as the wave generator, but also as the sensor for the wave dynamics; as waves travel across the flume, the local film thickness of the superfluid is changed, which can be optically read out. By increasing the optical intensity, we can generate a dissipative soliton, which locks onto the front of the sinusoidal-like fundamental mode of the wave flume due to its natural tendency to travel faster than the underlying wave. The addition of gain and loss to the system means that the dissipative solitary wave can maintain its amplitude and position along the wavefront ‘forever’, or as long as the optical drive is applied.

Authors: BAKER, Christopher (The University of Queensland); FOSHEE, Daniel (The University of Queensland); SLIM, Jesse (The University of Queensland); LUU, Nicole (The University of Queensland, Australia); BOWEN, Warwick (The University of Queensland)

Presenter: LUU, Nicole (The University of Queensland, Australia)

Session Classification: Condensed Matter & Materials

Track Classification: Topical Groups: Condensed Matter & Materials