

# Concepts in Theoretical Physics

University of Cambridge Part IA Mathematical Tripos

---

**Dr Natalia Berloff and Dr David Tong**

N.G.Berloff, D.Tong @damtp.cam.ac.uk

This course will provide an overview of theoretical physics with each lecture focussing on the essential elements of a different topic. Presentations for the lectures and suggestions for further reading can be found on the course website:

<http://www.damtp.cam.ac.uk/user/tong/concepts.html>

## Schedule

- April 23: **Principle of Least Action**, *David Tong*

The principle of least action; Unification of physics; Feynman's sum over histories.

- April 28: **Fluid Dynamics**, *Natalia Berloff*

Continuum model. Conservation of mass and the Euler's equation. Incompressible potential flow. Vortex motion. Turbulence.

- April 30: **Electromagnetism**, *Natalia Berloff*

Fundamental problem of electromagnetic theory. Electric and magnetic fields. Maxwell's Equations. Gauss's Law. Ampere's Law. Faraday's Law of induction. Electromagnetic waves.

- May 5: **Quantum Mechanics**, *David Tong*

The meaning of the wavefunction; GHZ correlations (a.k.a. experiments that defy logic)

- May 7: **Particle Physics**, *David Tong*

Either: Description of the particle zoo, Symmetries, Group theory.  
Or: What's going on with the LHC?

- May 12: **General Relativity**, *David Tong*

Idea of curved spacetime; Derivation of the Schwarzschild solution for black holes.

- May 14: **Chaos and Integrability**, *Natalia Berloff*

Chaos in deterministic equations. Lorenz attractor. Damped driven pendulum. Poincare section. Self-similar motion and scaling laws. Fractals. Cellular automaton: Game of Life. Integrability. Solitons of Korteweg-de Vries equation.

- May 19: **Cosmology**, *David Tong*

Some interesting subset of: What's the universe made of and how do we know? What happened at the big bang? Friedmann equations, Cosmic microwave background, String theory.