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Mathematics of cause, waves as particles, and mending broken hearts

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Harrison Lecture Theatre 4

Refreshments will be served after the presentation



One of defining, albeit not exclusive, features of life is "self-organisation". One can define that by saying that the causes of essential features of a system are contained within that system. Then it only remains to define what is "cause". I will discuss a particular mathematical definition of effect vs cause relationships as (infinitesimal) changes in the system's behaviour resulting from some perturbations, vs particular perturbations required to produce some changes. This is related to dual spaces and adjoint linear operators (which I will not touch) and can be readily implemented as computational algorithms (which I will illustrate).

Nontrivial relationship between causes and effects is observed in "spiral" and "scroll" waves, found in a variety of living (and not only) systems. The effects are wherever the wave reaches, whereas the causes are localised within its "core". As a result, spiral waves in two spatial dimensions behave as point-like objects, while scroll waves in three spatial dimensions behave like string-like objects (both of some finite "diameter"). Among the most important applications are some cardiac arrhythmias. I will present examples of important insights into mechanisms of these arrhythmias and possible ways of their treatment and prevention, provided by the theory.