Abstracts For 'The Mathematics of Time'

Michael Wright: 'Aspects of the Antikythera Mechanism, a Hellenistic astronomical gadget'.

The Antikythera Mechanism, a mechanical instrument displaying relationships between several astronomical and calendrical cycles – in effect a portable planetarium with supplementary displays – affords an unique direct insight into the accomplishment of the Hellenistic mechanician, with respect both to design and to execution. Rather than being exceptional, however, it should probably be seen as the fortunate survivor of a somewhat extensive practice of mechanical craft associated with astronomy which, ancient tradition asserted, was strongly associated with Archimedes. We will discuss some features of the mathematical astronomy on which its design is based and of the mathematics inherent in its mechanical realisation

Jim Bennett: 'Henry Sutton's Horary Quadrants and his Aspirations as a Mathematician'.

The London mathematical instrument maker Henry Sutton has been recognised since his own time as one of the most skilled engravers in his trade in seventeenth-century England. His versatility allowed him to work directly on brass or on wood and also in reverse on a copper printing plate. Thus much of his surviving oeuvre is bound into books, although a number of his printed instruments have survived as single printed sheets, applied to a brass plate or more usually a wooden board. He is particularly associated with the eponymous 'Sutton Quadrant', a study of which reveals his anxiety to be recognised as something more than a skilled engraver - an ambition that was only tenuously fulfilled. The book of John Collins, which was the vehicle for publicising the quadrant and its variants, reveals some of these tensions even in its curious title, *The Sector on a Quadrant*.

Crosbie Smith: 'Kelvin's Universe: Irreversibility, Dissipation and the Making of Energy Physics'.

Lord Kelvin (William Thomson) (1824-1907) was best known as the founder of the first physical (physics) laboratory in Britain, for a central role in establishing agreed units of measurement in physics and engineering, for the invention and patenting of navigational instruments (compass and sounding machine) and electrical instruments (esp. for telegraphy) and for his mathematical and experimental work in connection with submarine (esp. Atlantic) telegraphy. In this talk, however, I focus on his involvement in the making of energy physics with its two main principles of energy conservation and dissipation (irreversibility). First, I outline the contexts of Victorian marine engineering on the Clyde and Thames which gave impetus to his and his brother's new science of thermodynamics. Second, I examine his making of the new notion of irreversibility in these maritime contexts. And third, I summarise the ways in which he exemplified and extended this principle of energy dissipation in his investigations into the ages of the earth and sun. Finally, I look briefly at a few examples of how the "Kelvin Universe" was taken up in other contexts from literature to politics.

Claudia Cristalli: 'Unconscious Perception and Lived Experience. Peirce's Proposal of using Mathematical Continuity to justify his Theory of Perception'

In Charles S. Peirce's mature philosophy, Time is one of the physical functions in which his conception of Continuity is displayed. A mathematical and metaphysical conception at the same time, Continuity has been rightly regarded as the cornerstone of Peirce's later thought (Putnam 1992: 37, Potter & Shields 1997, Parker 1998). Putnam's (1992) reconstruction of the mathematical underpinnings of Peirce's continuum is still invaluable today. Drawing from such analysis, I further connect Peirce's notion of Continuity and Time with his engagement with James's notion of the stream of consciousness and with Peirce's own interests in perception and experience, as they emerge from Peirce's correspondence with James and from Peirce's 1902 manuscript *Telepathy*. Eventually, I show how Peirce's mathematical notion of Continuity feeds into his philosophy of perception and his enriched by his later phenomenological thought.

Robert Lambourne: 'Time, Relativity, and the Fourth Dimension'

Einsteinian special relativity is often taught as a four-dimensional theory of space and time, with time regarded as the fourth dimension. When properly explained, this makes good pedagogical sense, especially given Einstein's central role in the development of general relativity as an essentially geometrical theory of gravity. However, introducing special relativity as "general relativity without the gravity" fails to reflect the rich history that actually surrounded the birth of special relativity. This talk will present the key events in that story, including the 1905 publication of Einstein's foundational paper "On the electrodynamics of moving bodies". It will also describe the role of mathematicians, such as Hermann Minkowski, in helping to link the Einstein inspired revolution in physical thinking with contemporary conceptions in multi-dimensional geometry and the theory of invariants that would influence thought about time throughout the 20th Century and beyond.

Basil Hiley: 'Towards a Theory of Time in Quantum Gravity'

I will sketch the development of the notion of time in quantum mechanics from the non-relativistic theory to some of the more recent speculations in quantum gravity. I will discuss the notion of thermal time introduced by Connes and Rovelli and relate this approach to my theory of moments which was inspired by the discussion between Prigogine and Bohm. The emphasis will be on the mathematical aspect of the various approaches including the relationship to non-commutative geometry. The talk is related to the work of I. Prigogine who wrote 'From Being to Becoming: Time and Complexity in the Physical Sciences' in 1980, A. Connes and C. Rovelli, who wrote 'Von Neumann algebra automorphisms and time thermodynamics relation in generally covariant quantum theories' in 1994, and my paper 'Time and the algebraic Theory of Moments' in 'Re-thinking Time at the Interface of Physics and Philosophy: The Forgotten Present' published in 2015.

Joan Vaccaro: 'A New and Original Approach to Solving the Problem of the Violation of Time Symmetry'

The discrete symmetries of charge conjugation, parity inversion and time reversal are violated by dynamics; that is, the *violations occur for translations in time, not space*. I recently introduced a new sum-over-paths formalism to explicitly incorporate this distinction between space and time. The formalism treats time and space on the same footing at a fundamental level such that, in the absence of the discrete symmetry violations, an object is represented as existing only in the neighbourhood of a particular point in time and space. The localisation in time reflects the *lack of dynamics and conservation laws* at a fundamental level in the theory. However, when the discrete symmetry violations are included, the object is represented as dynamically evolving over time and obeying conservation laws. Dynamics and conservation laws appear not to be elemental features of nature as currently assumed, but rather phenomenological repercussions of the discrete symmetry violations.