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Physics of Blockchain Systems[1]

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Nowadays, most facets of human behaviour are pervaded by technical systems that facilitate our information and economic exchanges. In the last years, aiming at more resilient and scalable designs, these systems have transitioned towards decentralised concepts. Blockchain has disrupted the way of thinking distributed systems: This mechanism allows the secure diffusion of information across a network without the need of a central (trusted) authority to enforce the emergence of consensus. Indeed, as a primary example, the digital currency Bitcoin is implemented on top of a blockchain, and its value is solely assigned by a (largely speculative) market. This talk is divided into two parts. First, the analysis of Bitcoin as a closed economy: having followed a technocratic approach in its immutable design, it is the only case of an economy where all monetary transactions can be traced back with full detail. Interestingly, its fixed incentive scheme has created the emergence of large levels of centralisation and economic flow, drastically different from its original conception. Blockchain-based systems are underlain by decentralised peer-to-peer networks. While in the last years the number of its applications has increased enormously, little is known about their suitability in stressed working conditions. In the final part of this presentation we introduce a parsimonious modelling approach (an extension of the celebrated Gillespie algorithm) for these systems, identifying a phase transition from consensus in the diffusion of information to a frustrated (congested) state where the efficiency of these systems rapidly deteriorates.

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