Exploring strangeness and the primordial Universe

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Physicists believe that in the Universe's first ten microseconds free quarks and gluons filled all of spacetime, forming a new phase of matter named 'quark-gluon plasma' (QGP). Experimental and theoretical work

at CERN was instrumental in the discovery of this hot soup of primordial matter, which is recreated today in accelerator-based lab experiments. To discover QGP in such experiments, the observation of exotic 'strange' quarks is very important. If QGP is created, strangeness is readily produced through collisions between gluons. In analysis published in *EPJ ST*, Dr. Johann Rafelski from The University of Arizona, United States, also working at CERN, presents how our understanding of this characteristic strangeness production signature has evolved over the span of his long career.

Using the style of a 'personal diary,' Rafelski firstly reviews and summarises decades of work. Describing leading experimental and theoretical contributions, he recounts how and why strange quarks are produced so efficiently in QGP, and how this behaviour has been exploited for QGP discovery. He also explores strangeness as a tool in the search and discovery of this primordial phase of matter; existent at unimaginably high temperatures and pressures. He then follows the line of research through to the ongoing experimental ultra-high-energy experiments involving head-on collisions between both heavy nuclei and lighter protons, carried out at CERN's Large Hadron Collider (LHC).

Secondly, Rafelski follows the narrative with a commented set of his own unpublished work, focusing on pioneering theories and QGP discovery. He also includes a selection from the comments of referees offering both criticism and praise for these studies; along with his own present-day perspectives. This review highlights the numerous successes enjoyed by theorists, through decades of tireless effort to explain and understand the primordial QGP. All the same, it shows that many pressing questions remain to be answered. Rafelski continues to contribute to the field through his rich research experience and will undoubtedly inspire new generations of physicists to continue the study of exotic quarks in the primordial Universe.

More information: Johann Rafelski, Discovery of Quark-Gluon Plasma: Strangeness Diaries, *The European Physical Journal Special Topics* (2020). DOI: 10.1140/epjst/e2019-900263-x