A Vector-Scalar Field Model for the Dynamics of the Early Universe

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The advent of modern satellite technology in observational astronomy has ushered in a new era for astrophysics and research into the fundamental role of gravitation on a large scale. In particular the venerable subject of relativistic cosmology has received a new impetus with the realisation that a number of standard cosmological models may need revision. In this presentation we discuss an alternative paradigm that, while retaining many of the most established features of the current standard model, circumvents some of its weaknesses. We invoke a new mechanism for reducing Einstein's field equations (without a cosmological constant term) to a dynamical system that possesses a class of *simple analytic* solutions exhibiting characteristics of immediate relevance to current observational astronomy.

The first part of the talk will briefly outline some aspects of the standard approach and draw attention to those weaknesses that have motivated our approach. This is formulated as a classical field theory of self-interacting vector and scalar fields dynamically coupled to Einstein gravity on spacetime with a fixed closed spatial topology. For its application to early Universe cosmology we exploit the symmetries of the 3-sphere to construct a particular ansätz for these fields and a hyper-cylindrical spacetime Lorentzian metric. We then explicitly construct a class of general analytic solutions for the dynamical system using local charts on spacetime familiar from LFRW cosmological models. In particular charts these solutions involve only trigonometric functions, square roots and a set of arbitrary integration constants.

It will be shown how these solutions can be used to describe different types of early Universe evolution with reference to the cosmic time dependence of the metric scale factor, the Hubble and de-acceleration functions, the scalar spacetime curvature and the Kretschmann invariant constructed from the Riemann-Christoffel spacetime curvature tensor. We emphasise that the model does not require externally prescribed fluid equations of state and leads to a number of new predictions including the possibility of Hopfian-like configurations that may contribute to Maxwell electromagnetic fields. Finally we discuss the relevance of our model to recent astrophysical observations and speculations about the origin of *dark energy and matter* together with the mass of the photon in this context.