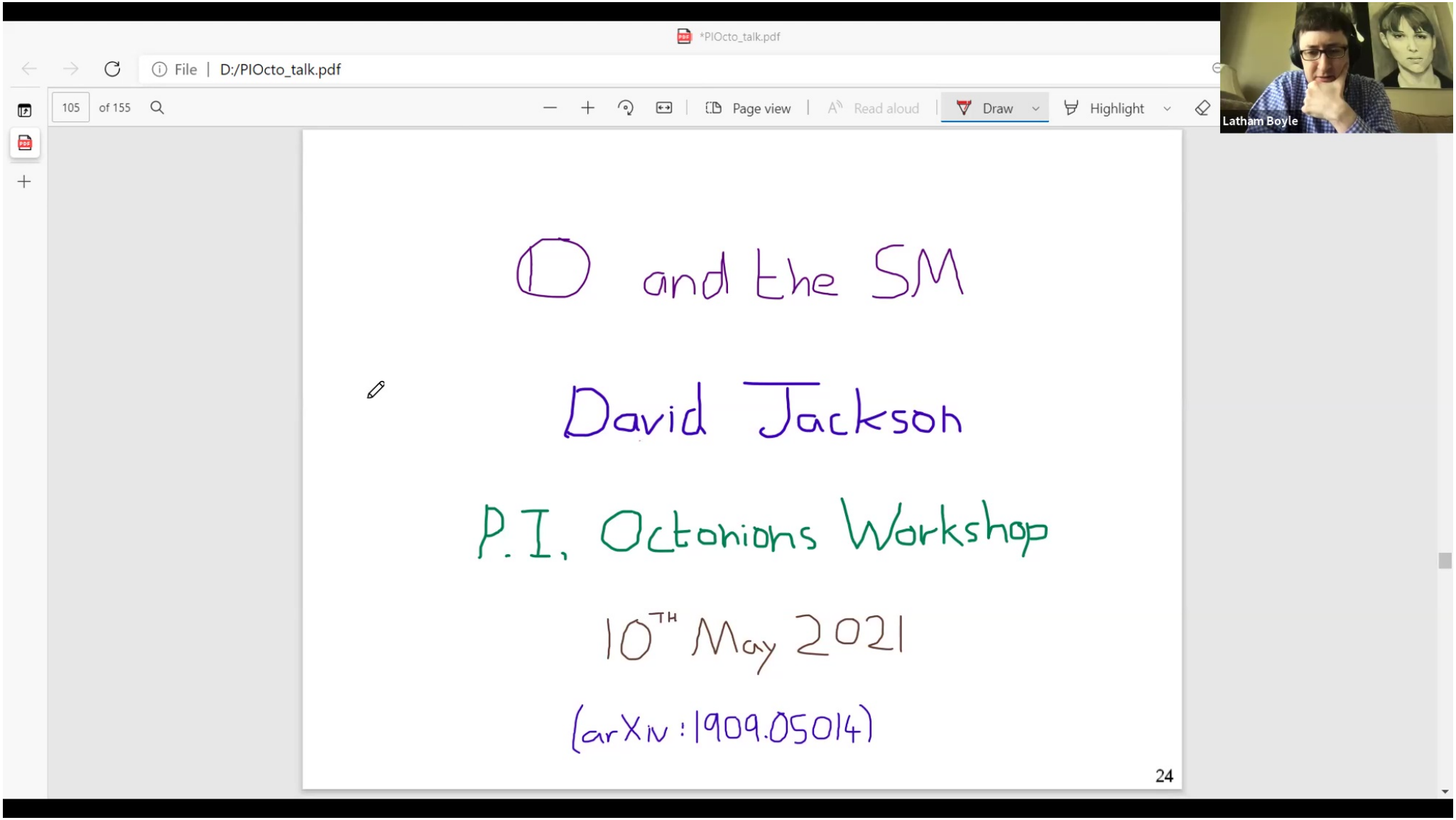
Title: Discussion Session

Speakers: Tejinder Singh, Shane Farnsworth, Cohl Furey, Jochen Szangolies, David Jackson

Collection: Octonions and the Standard Model

Date: May 10, 2021 - 12:00 PM

URL: http://pirsa.org/21050004


*PIOcto_talk.pdf
File | D:/PIOcto_talk.pdf
105 of 155
Page view
Read aloud
Draw
Highlight
Latham Boyle
O and the SM
David Jackson
P.I. Octonions Workshop
10TH May 2021
(arXiv:1909.05014)
24

Fine Structure Constant 1/137 From the Octonions

Tejinder P. Singh
TIFR, Mumbai

May 10, 2021

Octonions and the Standard Model
Perimeter Institute

Geometry of the 3-Qubit State, Entanglement and Division Algebras

Bogdan A. Bernevig
Department of Physics, Stanford University, Stanford, California 94305

Han-Dong Chen
Department of Applied Physics, Stanford University, Stanford, California 94305

We present a generalization to 3-qubits of the standard Bloch sphere representation for a single qubit and of the 7-dimensional sphere representation for 2 qubits presented in Mosseri *et al.*[1]. The Hilbert space of the 3-qubit system is the 15-dimensional sphere S^{15}, which allows for a natural (last) Hopf fibration with S^8 as base and S^7 as fiber. A striking feature is, as in the case of 1 and 2 qubits, that the map is entanglement sensitive, and the two distinct ways of un-entangling 3 qubits are naturally related to the Hopf map. We define a quantity that measures the degree of entanglement of the 3-qubit state. Conjectures on the possibility to generalize the construction for higher qubit states are also discussed.

I. INTRODUCTION

Quantum mechanics exhibits its difference from classical physical theories in many aspects. A quintessential property of quantum mechanics is quantum entanglement. Quantum entanglement rests at the center of the applications such as quantum information and quantum computing. Maximally entangled EPR pair[2] is an essential ingredient of teleportation[4], dense coding[3], and quantum key distribution[5,6]. The maximally entangled 3-qubit GHZ state[7] and the m-cat state are of cardinal importance to the applications such as cryptographic conferencing or superdense coding[8], quantum secret sharing or quantum information splitting[9]. Due to the entanglement of the Hilbert space states, it is a highly non-trivial problem to understand the properties of multi-qubit states. Recently, it has become clear[1] that the properties of the first two simplest qubit states, the single qubit and the 2-qubit state, are very deeply related to two very important mathematical objects, the first two Hopf fibrations $S^3 \xrightarrow{S^1} S^2$ and $S^7 \xrightarrow{S^3} S^4$. The global phase freedom of the single qubit state and the entanglement which appears for the first time starting with the 2-qubit case have been proven to be deeply related to the Hopf fibrations. For an entangled 2-qubit state, performing a transformation on the first qubit space induces a transformation on the space of the second qubit space. This

1 Impromptu talk about Bison algebras and electroweak theory

Shane Farnsworth

A last-minute description
future investigations

N. Furey
2021.05.10