



HARVARD UNIVERSITY
17 Oxford Street
Cambridge, MA 02138

Mathematical Picture Language Seminar



Tuesday, October 20

3:00 p.m. Boston time

Jefferson 368

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4D Hex and Baby Yang-Mills

Abstract: The 2D $O(n)$ model is a very close analog of 4D lattice Yang-Mills. The quest to understand the former (mass gap, scaling limit, etc.) has been colloquially called the "baby Yang-Mills problem" or the "half million-dollar-problem." Now, several recent OpenAI papers on the 2D $O(n)$ model (one of which comes with Lean code) claim to have solved much of this problem. But how exactly is this relevant to 4D Yang-Mills?

I will review and explain how the 2D model derives special properties from the identity $1+1=2$ while the 4D model derives special properties from the identity $2+2=4$. The 2D model is related to random loop ensembles, while the 4D model is related to random surface ensembles. I will discuss the new proofs and the challenges involved in constructing analogous proofs in 4D. As a warmup, try playing a few games of 2D Hex (players compete to make spanning paths on a 2D board) and 4D Hex (players compete to make spanning surfaces on a 4D board) and think about what makes the second game harder to analyze.

This talk will be posted two days after the seminar at

<https://mathpicture.fas.harvard.edu/seminar> and

<https://www.youtube.com/@mathematicalpicturelanguage2715/videos>