THE INTRINSIC MULTIVERfal VERSION OF THE
MILLENIUM YM EXISTENCE AND MASS GAP PROBLEM

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Abstract. Artin Presentation Theory (AP Theory) is a purely mathematical, multiversal, rigorous holographic smooth theory of (3 + 1)-D manifolds, with many undeniable qualitative physical analogies with the most important, but still heuristic, theories of modern physics. The aim of this short note is to carefully pinpoint its analogies with the YM Existence and Mass Gap problem. Despite its conceptual simplicity, the pure framed braid-theoretic AP Theory is highly non-trivial: among other things, it is characteristic of (3 + 1)-D, encodes all closed, orientable 3-manifolds, has a very sharp concept of holography and has a purely AP-theoretic analogue of the classical Donaldson’s Theorem, (which is rooted in classical QFT). We make no physical assertions except pointing out mathematical analogies.

1. Introduction

For a short introduction and basic references to AP Theory, see [W].

A typical multiversal analogy of AP Theory with, e.g., AdS/CFT Duality, is the very sharp holography of AP Theory: in AP Theory, a compact, connected, smooth, simply-connected (3+1)-D manifold, with a connected boundary, is already determined by a presentation, namely an Artin presentation, of the fundamental group of that boundary, even if the latter is the trivial group, [W], p.2.

Just as in Cobordism Theory, AP Theory, a priori, studies all its manifolds at the same time; it does not just concentrate on one single manifold, e.g., like anti-de Sitter space.

One fundamental reason for the conceptual simplicity of AP Theory is: its topology does not come from, say, elaborate analytical PDE moduli constructs. AP Theory starts, [W], p.2, with 2D flat, non-infinitesimal, but still smooth, topology, just as, e.g., Hasse, in 1923, famously started with the rational numbers, instead of the integers, to study rational quadratic forms. See [O] for an illuminating, concise description of the importance of such a meta-mathematical shortcut. (In physics, a very famous such shortcut is, of course, that of Heisenberg on Helgoland in 1925, restricting himself to 'observables' only.)

In AP Theory the correspondence \( r \rightarrow W^4(r) \), i.e., from the strings \( r \), ([W], p.4), to the universes \( W^4(r) \), is a very general multiversal LOC-GLOB principle.

Since the Torelli interactions/transitions, [W], p.5, act simultaneously on both the 'particles' \( r \) and the 'quantum fields' \( h(r) : \Omega_n \rightarrow \Omega_n \), they can be considered to be non-abelian gauge symmetries; in AP Theory the Torelli symmetries form the universal gauge group.

It should be clear, since AP Theory does not use any analytical equations, nor \( \infty \)-D Hilbert space, nor classical SUSY, etc., that the whole of AP Theory, is the AP analogue of the multiversal version of the so-called \( \mathcal{N} = 4 \) Super 4D YM Theory,
in the planar limit’, the classical maximally supersymmetric gauge theory in four dimensions, the simplest classical non-trivial QFT.

This is also the AP analogue to ‘a quantum gauge theory in four dimensions’, to ‘Quantum YM Theory’, [V], [GB], [JW], p.3, as well as the AP ‘breaking’ of classical ‘unified gauge symmetry’, [Wk], p.11.

Another analogy is that of AP Theory as a QFT: the \( h(r) : \Omega_n \to \Omega_n \) are the AP ‘quantum fields’, which are so small and primitive, that their ‘localized vibrations’ (i.e., particles), consist of the single string particle \( r \), which also determines the field, up to isotopy, [W], p.2. Thus, AP Theory as a background-independent string theory, [W], p.4, extends the concept of a QFT in AP Theory. Now the fields \( h(r) : \Omega_n \to \Omega_n \) can also be considered to be wave-packets, which are also the intrinsic worldsheets of the string \( r \). This illustrates the unifying power of AP Theory, at the multiversal level, due to its non-analytic topological conceptual simplicity.

We quote Witten in [Wi]: “Based on real experiments and computer simulations, quantum gauge theory in four dimensions is believed to have a mass gap. This is one of the most fundamental facts that makes the universe the way it is.”

Our challenge is to substitute the quantitative arguments of the classical analytical versions of the mass gap problem, [V], [GB], and the positive constant \( \Delta \) of p.3 of [JW], (i.e., the lower bound of the 'energy of any vacuum excitation’), by qualitative, topological concepts, just as was done with the Planck constant on p.2 of [W].

In fact, if we recognize \( r \) as a string particle, [W], p.4, then \( r \) acquires (membranic) mass wth the \( h(r) : \Omega_n \to \Omega_n \), by a theorem of González-Acuña, see [W], p.2, and then in AP Theory there are no mass-less particles, which is a non-quantitative solution to the mass gap problem. (see also Remark v) below).

In AP Theory, the quantitative Planck constant \( h \) and the [JW] mass gap constant \( \Delta \) are substituted by the same qualitative concept, namely the correspondence \( r \to h(r) : \Omega_n \to \Omega_n \) of González-Acuña’s Theorem, [W], p.2.

AP Theory is a ‘detached’, autonomous, qualitative theory, where fundamental numerical constants of physics are substituted by genuine qualitative analogies, of what these numerical constants cause qualitatively.

Needless to say, the mere metamathematical existence of the corollary of Donaldson’s Theorem in AP Theory (see p.2 of [W]) augments this considerably, since Donaldson’s theory is rooted in classical QFT, see [JW], p.4.

Thus in AP Theory there is no open, unsolved mass gap problem.

It is a theorem of González-Acuña, [W], p.2, used at the very foundation and beginning of AP Theory.

AP Theory, which is not a mere mathematical/physical ‘model’, gives a metamathematically smooth, \((3 + 1) - D\) topological incarnation, so to speak, of the mass gap, in a multiversal context.

AP Theory’s sheer mathematical existence substitutes for the existence of a mass gap, in the multiversal case.

Multiversally, the mass gap problem is not solved by mere analytic theorems, but instead with the sheer metamathematical existence of a rigorous theory, namely AP Theory.
2. Remarks

i) Conjecture: AP Theory as the multiversal Incarnation of Mass Gap, should imply, at least in the multiversal case, 'positive vacuum energy density', i.e., a positive cosmological constant.

ii) AP Theory’s predictive power is, a priori, just mathematical: suppose the purely discrete group-theoretic Theorem on p.2 of [W] were wrong; i.e., there existed an Artin presentation \( r \), of the trivial group, such that, say, \( A(r) = E_8 \); then the analytic, curvature-using classic Donaldson Theorem would have been false. Compare also to remark 4 of section 5 of [W].

iii) If closed, smooth, simply-connected four-manifolds are 'physical', so is AP Theory, see [W], p.2.

iv) See Wilczek, [Wk], for the importance and necessity of having multiversal versions of a physical theory.

v) 'Giving (membranic) mass' to all AP particles, i.e., the \( r \), also gives similarities to AP Theory as a Higgs field, in a purely mathematical manner. In modern physics, the Higgs field is brought in by hand and its physical origin is unknown.

References


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