Yang-Mills Theory: A proof that the lowest excitations have a finite mass gap in regard to the vacuum state(Yungg-Millz)

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Abstract

The Yang-Mills Theory hypothesis concerns itself with proving a finite mass gap relative to the vacuum state. The Yang-Mills theories are a special group of gauge theories with non-abelian symmetry, given by the Lagrangian. [1]

1. *Proof of the existence of a finite mass gap*

Proof.

The Lagrangian of the Yang-Mills Theories is

$$\mathcal{L} = -\frac{1}{2}Tr(F^2) = -\frac{1}{4}F^{\alpha uv}F^{\alpha}_{\mu v}.$$

knowing $Tr(T^a)(T^b) = \frac{1}{2}\delta^{ab}$.

$$Tr(F^{\alpha\mu v}F^{\alpha}_{\mu v}) = \frac{1}{2}\delta^{\alpha^2}_{\mu v}$$

$$" \frac{1}{4}\delta^{\alpha^2\mu v}_{\mu v} = 0$$

and

$$\frac{1}{4}F^{\alpha uv}F^{\alpha}_{uv} = 0$$

When counting from the vacuum state, which is essentially 0, one must use a method that requires counting. The best methods for things like this is to take the square root or natural logarithm, as both these methods require counting to a total.

Taking the square root[**2**]

$$\frac{\sqrt{2}}{2}F^{\alpha\mu v\frac{1}{2}}F^{\alpha\frac{1}{2}}_{\mu v} = \sqrt{0}$$

$$0^{\frac{1}{2}} = e^{iln(cos(\frac{1}{2}ln|0|)+isin(\frac{1}{2}ln|0|))}$$

$$0^{\frac{1}{2}} = (cos(\theta) - isin(\theta))e^{arg|w|}$$

$$\frac{\sqrt{2}}{2}F^{\alpha\mu v\frac{1}{2}}F^{\alpha\frac{1}{2}}_{\mu v} = (cos(\theta)isin(\theta))e^{arg|w|}$$

$$\frac{\sqrt{2}}{2}\delta^{\alpha\frac{1}{2}\mu v}_{v\mu} = (cos(\theta) - isin(\theta))e^{arg|w|}$$

$$\frac{\sqrt{2}}{2}\delta^{\alpha\frac{1}{2}\mu v}_{\mu v} = (cos(\theta) + isin(\theta))e^{arg|w|}$$

$$\delta^{\alpha\frac{1}{2}\mu v}_{\mu v} = \sqrt{2}(cos(\theta) + isin(\theta))e^{arg|w|}$$

From here you are required to get the mass.

As δ is $\equiv$ to the Force Tensor F, we can state. .. F = ma

$$\sqrt{F} = m$$

As at 0 m=a.

Continuing we can say...

$\delta^{\alpha\frac{1}{2}\mu v}_{\mu v} = F$. As $\delta = \mathcal{O}(F)$. Therefore we now say that.

$$\delta^{\alpha\frac{1}{4}\mu v}_{\mu v} = \sqrt{2}^{\frac{1}{2}}(cos(\tfrac{1}{2}\theta) + isin(\tfrac{1}{2}\theta))e^{arg|\frac{1}{2}w|}$$

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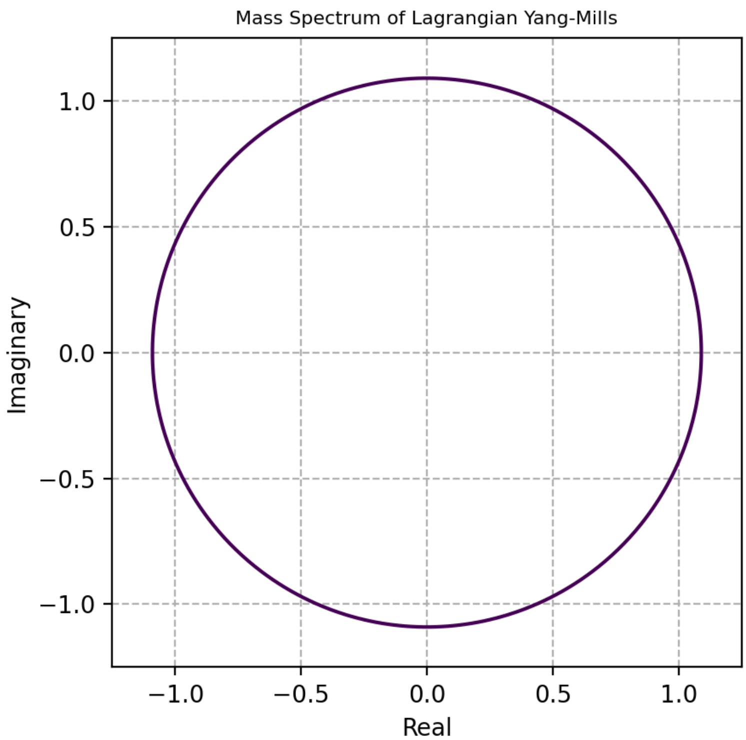

FIGURE 1. *Mass Spectrum*

and then. $m = \sqrt{2}^{\frac{1}{2}}(cos(\frac{1}{2}\theta) + isin(\frac{1}{2}\theta))e^{arg|\frac{1}{2}w|}$
This is the mass spectrum which we shall use to prove the finite mass gap in relation to the vacuum state.

□

The existence of a finite mass gap is proven by the 'precision' of the 'Ivan Orbit'. In short, any spectrum calculated produces a minimum number (finite mass gap). This proves the mass gap through fundamental mathematical logic, as any position along the axis can be chosen and any position will produce a spectrum with a finite mass gap between itself and 0.

A calculation of the mass gap can be done at any arbitrary point, but the points of $\frac{1}{2}and\frac{1}{4}$ have been chosen.

The calculations performed are similar to the ones performed when calculating the Riemann Zeros[**?**] so I shall only provide a preliminary answer here. For $\frac{1}{2}$ the mass gap is ≈ 67 and for $\frac{1}{4}$ the mass gap is ≈ 1.148.

This concludes the Yang Mills Hypothesis.

References

1. Arthur Jaffe and Edward Witten, Quantum Yang-Mills Theory (Clay Mathematics, Year Not Said).
2. J I Samuels, 'A Proof of the Riemann Hypothesis', *ResearchGate* 2020