Measuring the size of the Higgs

Axel Maas

8th of April 2022

 \rightarrow 2204.02756 with Patrick Jenny & Bernd Riederer







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And why there is Standard Model background

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 - Is there a background from the standard model?

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 - Higgs and Z need to be both produced in the same process
 - Elastic scattering
 - Standard vector boson scattering process at low energies
 - Use this one



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Legendre polynom

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Scattering length~"size" Phase shift

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• Consider the Higgs: J=0



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 - Subtle field-theoretical effect
 - Known since the early 1980ies
- Physical states are actually bound states
 - True for all weakly interacting particles



• Review: 1712.04721

[Fröhlich et al.'80,'81 Maas'12,'17]

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Higgs field

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Standard Perturbation Theory

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- $\langle (h^+ h)(x)(h^+ h)(y) \rangle = v^2 \langle \eta^+ (x)\eta(y) \rangle$ Deviations: 2009.06671 + $v \langle \eta^+ \eta^2 + \eta^{+2} \eta \rangle + \langle \eta^{+2} \eta^2 \rangle$ 3) Standard perturbation theory

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[Maas, Mufti'15 Afferrante,Maas,Sondenheimer,Törek'20]

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- Qualitative outcome
 - FMS construction
 - Mass defect

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- With quenched fermions
 - Many simplifications
 - Compressed mass scales
 - One generation
 - Degenerate leptons and neutrinos
 - Dirac fermions: left/righthanded non-degenerate
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 - Flavor and custodial symmetry patterns



Impact on the radius of the Higgs

- Reduced SM: Only W/Z and the Higgs
 - Parameters slightly different
 - Higgs too heavy (145 GeV) and too strong weak coupling
 - Qualitatively but not quantitatively

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 Modifications of the cross section close to threshold in VBS could hint to a composite nature of the Higgs

- There is unaccounted-for SM background in this measurement
 - Or: Guaranteed discovery of either the effect in the SM or a serious theoretical problem

→ 2204.02756, 1712.04721