Where is tree-level heterotic string theory?

Waltraut Knop

based on [M. Boisvert, WK, L. Rastelli: 2406.12959]

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- What matter/spectrum is consistent?
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Is string theory the unique solution?

see e.g. [Chandorkar, Chowdhury, Kundu and Minwalla: 2102.13122]
[Häring, Zhiboedov: 2202.08280]
[Correia, Sever, Zhiboedov: 2006.08221]

$2 \to 2$ graviton scattering: basics

see e.g. [Chandorkar, Chowdhury, Kundu and Minwalla: 2102.13122]
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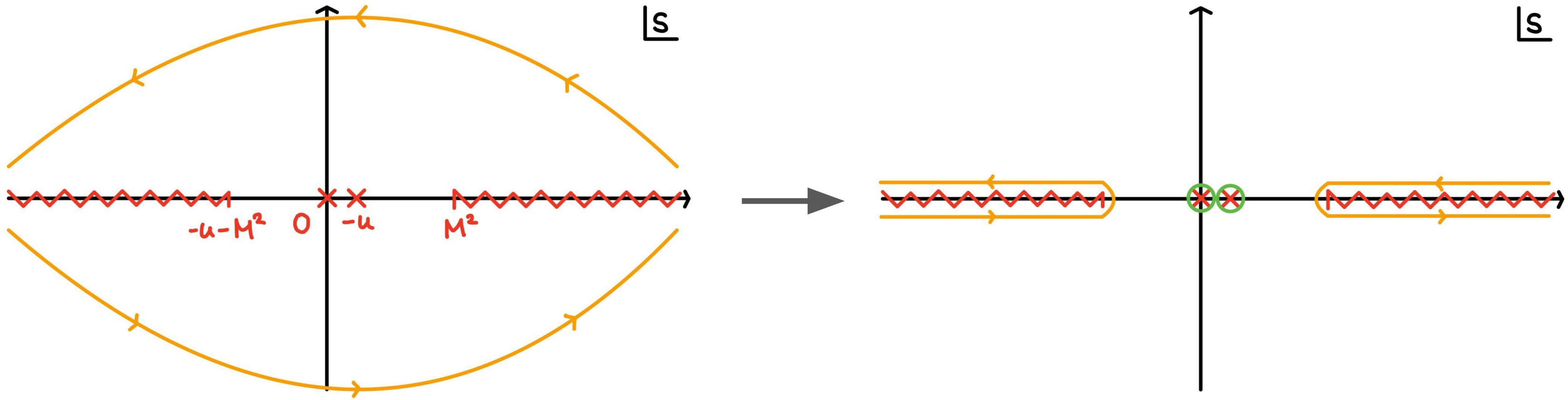
- Tree-level: meromorphic

Lightning summary: sum rules



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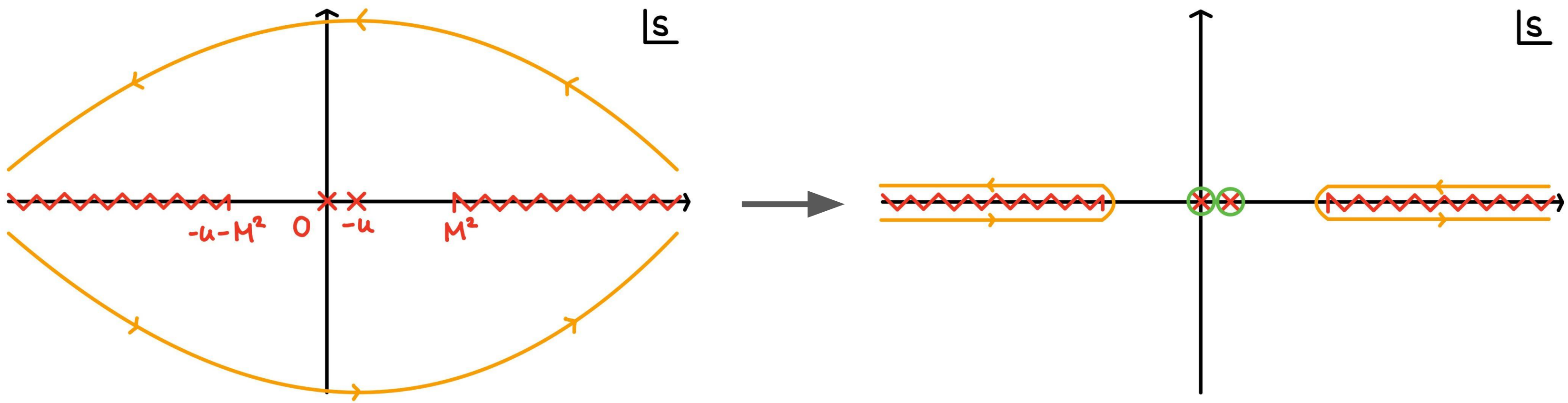

$$\operatorname*{Res}_{s=0,-u}\left[\frac{\mathcal{M}_{\rm IR}(s,u)}{s[s(s+u)]^{k/2}}\right] = \left\langle \frac{2m^2+u}{m^2+u}\frac{\mathcal{P}_J\left(1+\frac{2u}{m^2}\right)}{[m^2(m^2+u)]^{k/2}} \right\rangle$$

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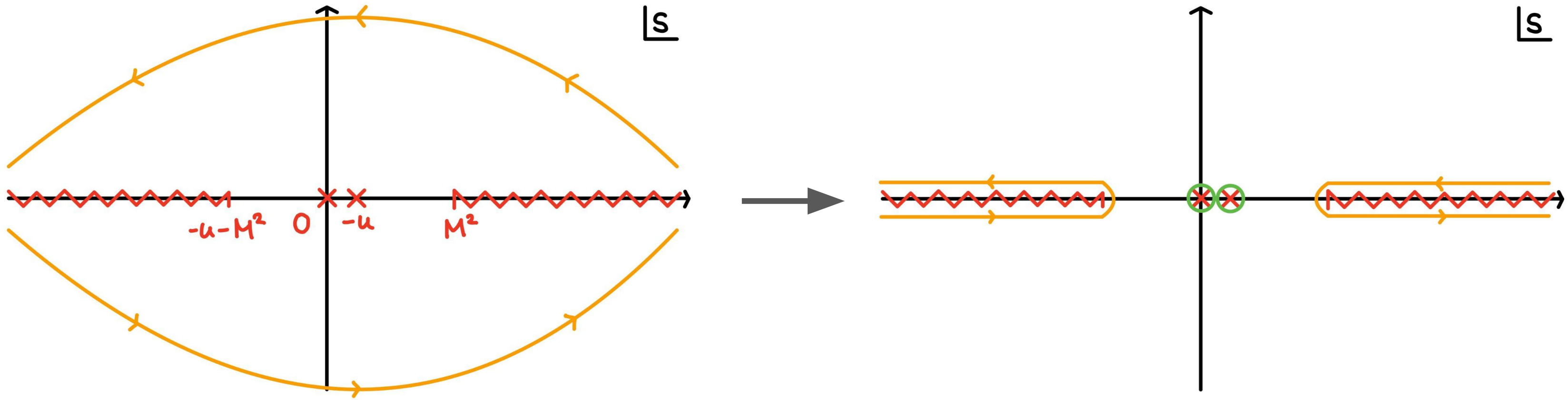

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$\rightarrow$ **Goal:** bound $\frac{g_2}{8\pi G}$ and $\frac{g_4}{8\pi G}$

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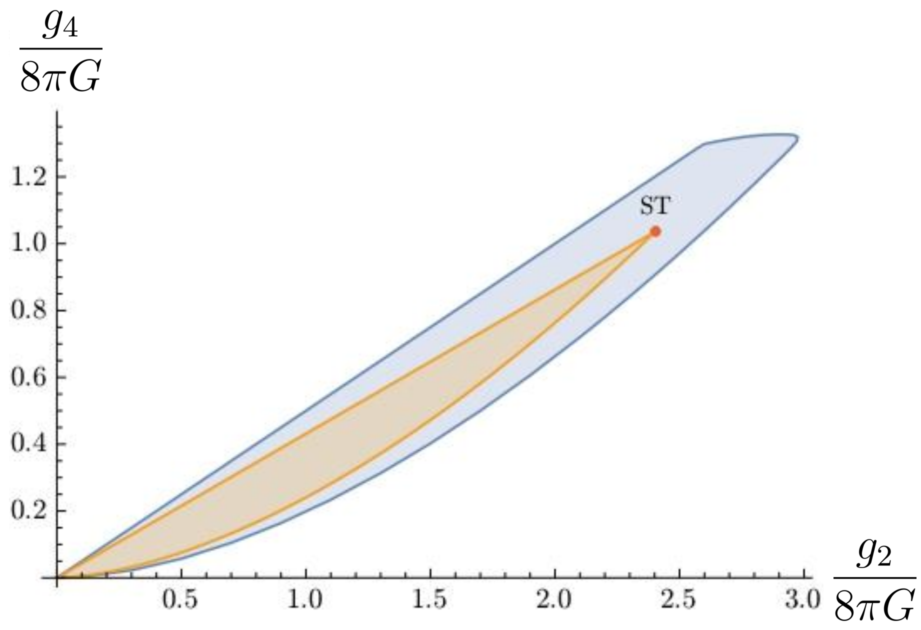

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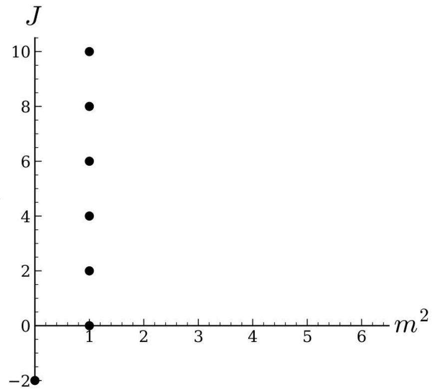

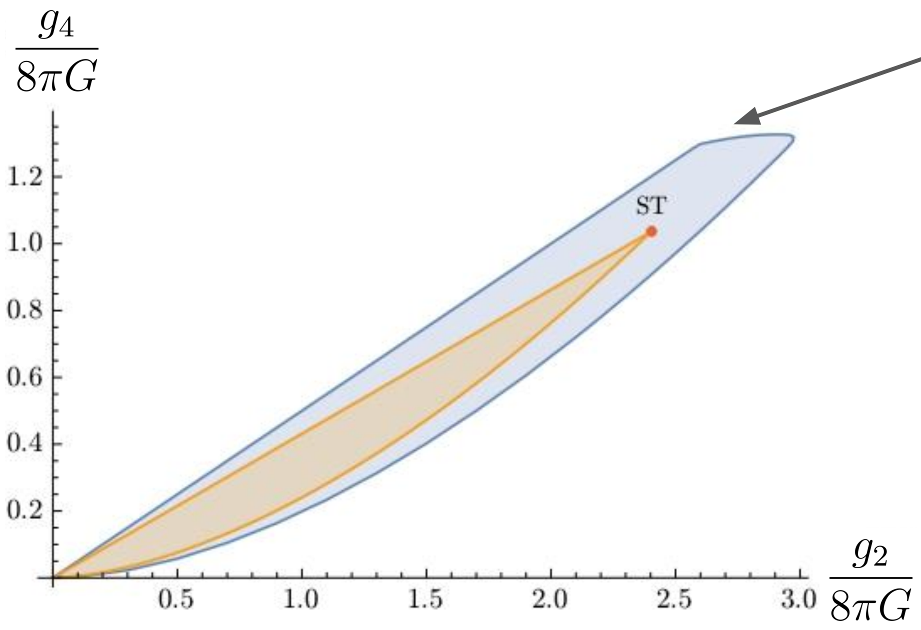

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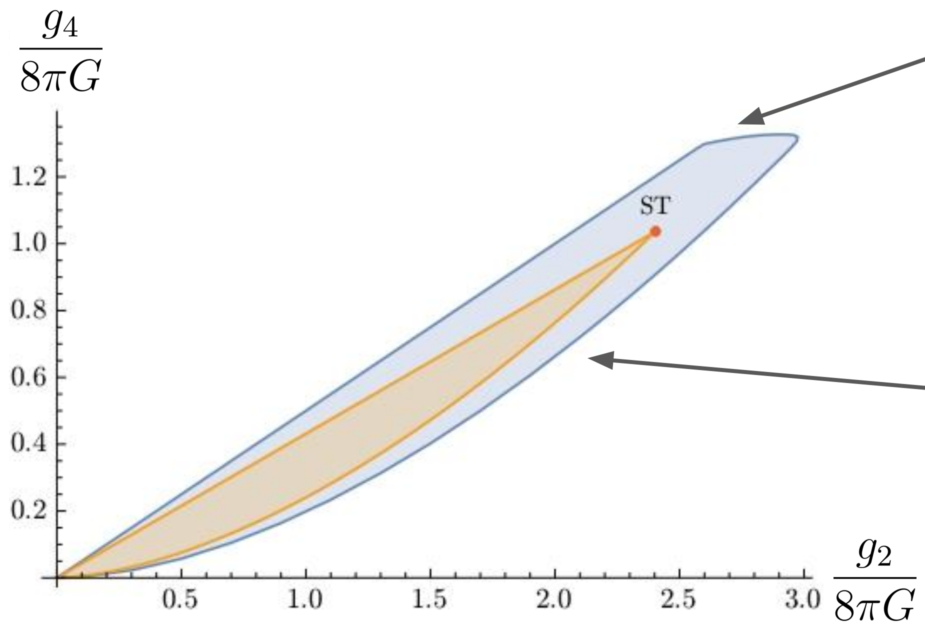

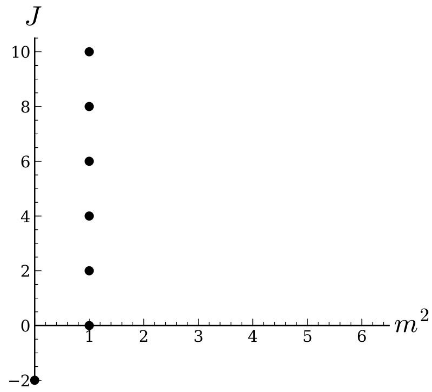

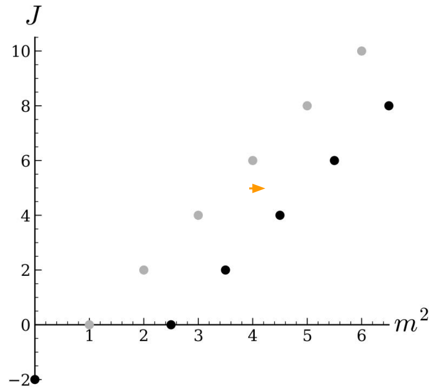

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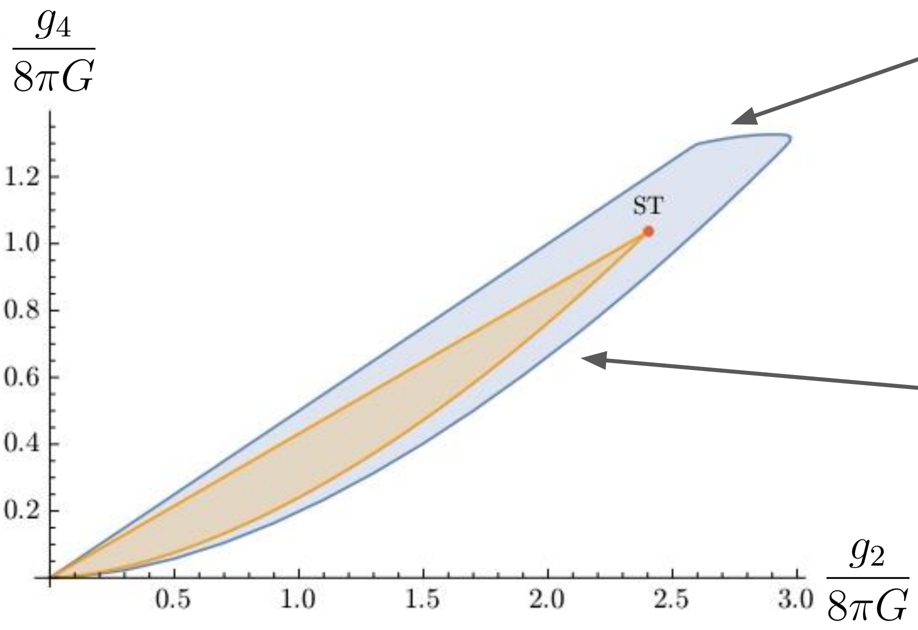

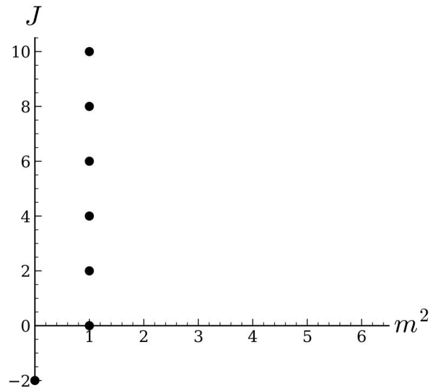

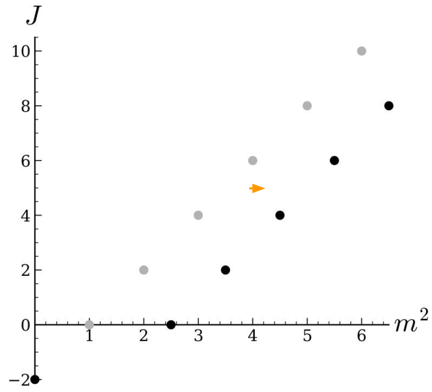

Do these solutions extend to less susy?

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Susy Scalar: [Berman, Elvang, Geiser, Lin: 2412.13368]

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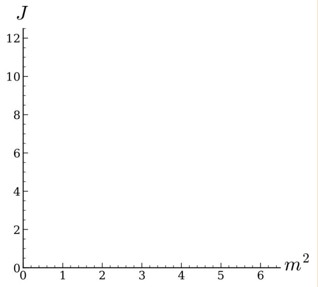

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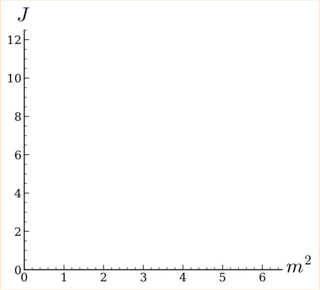

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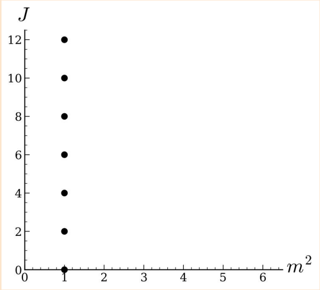

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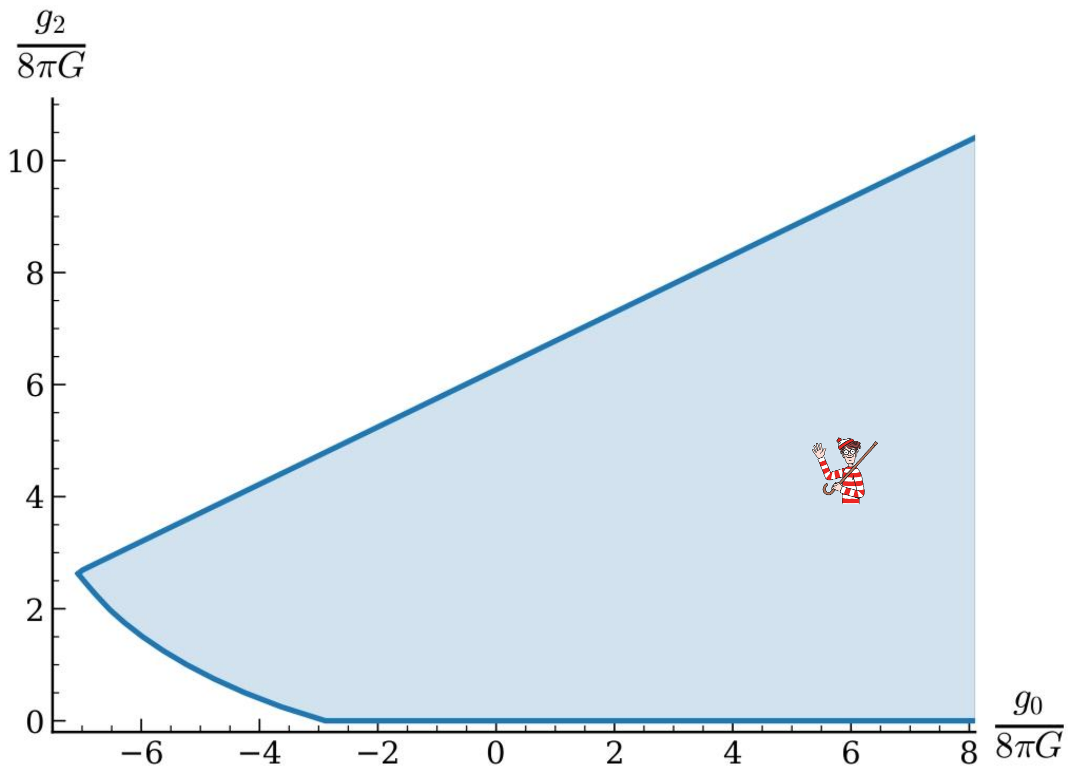

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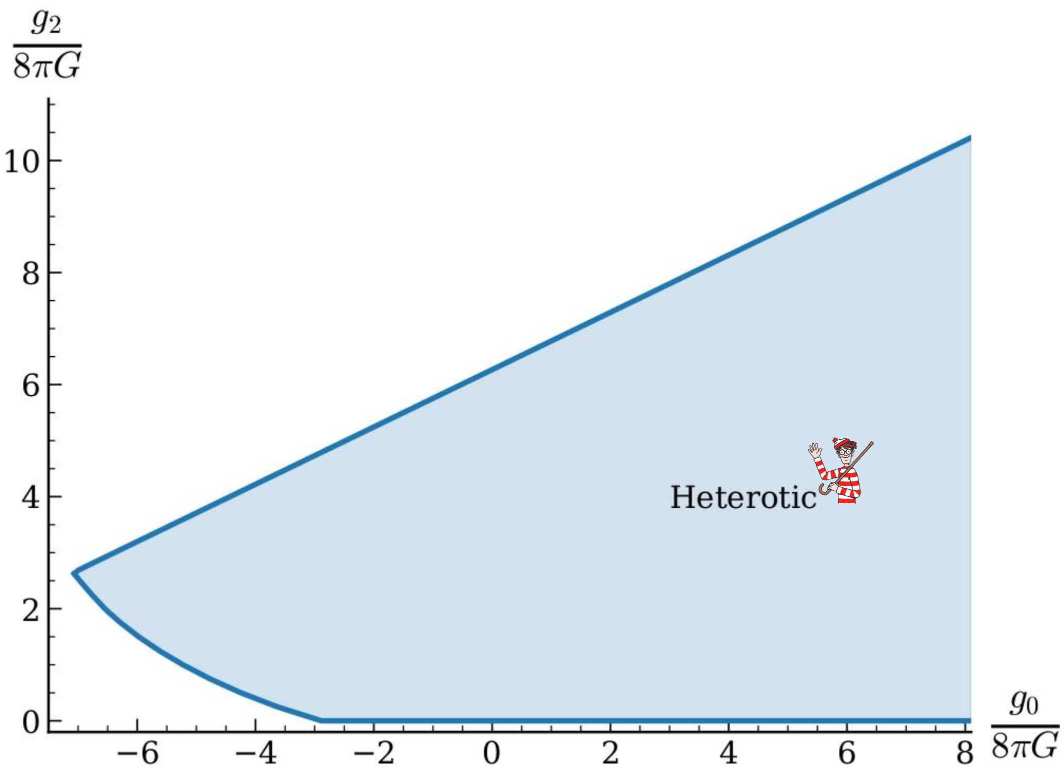

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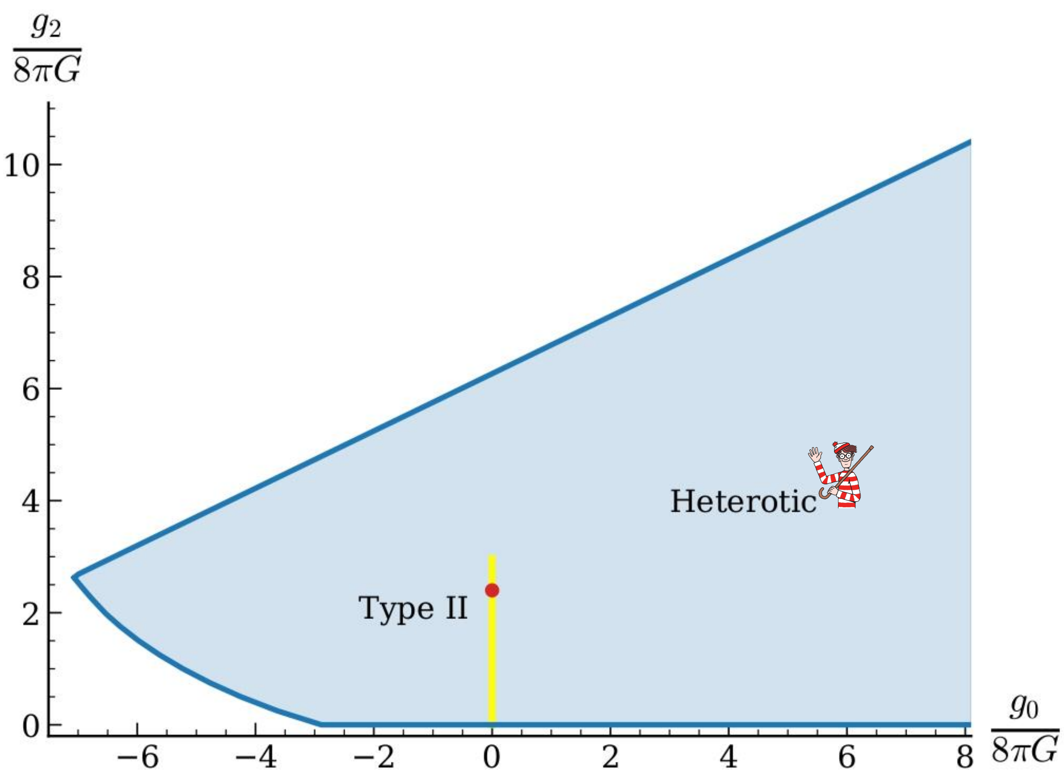

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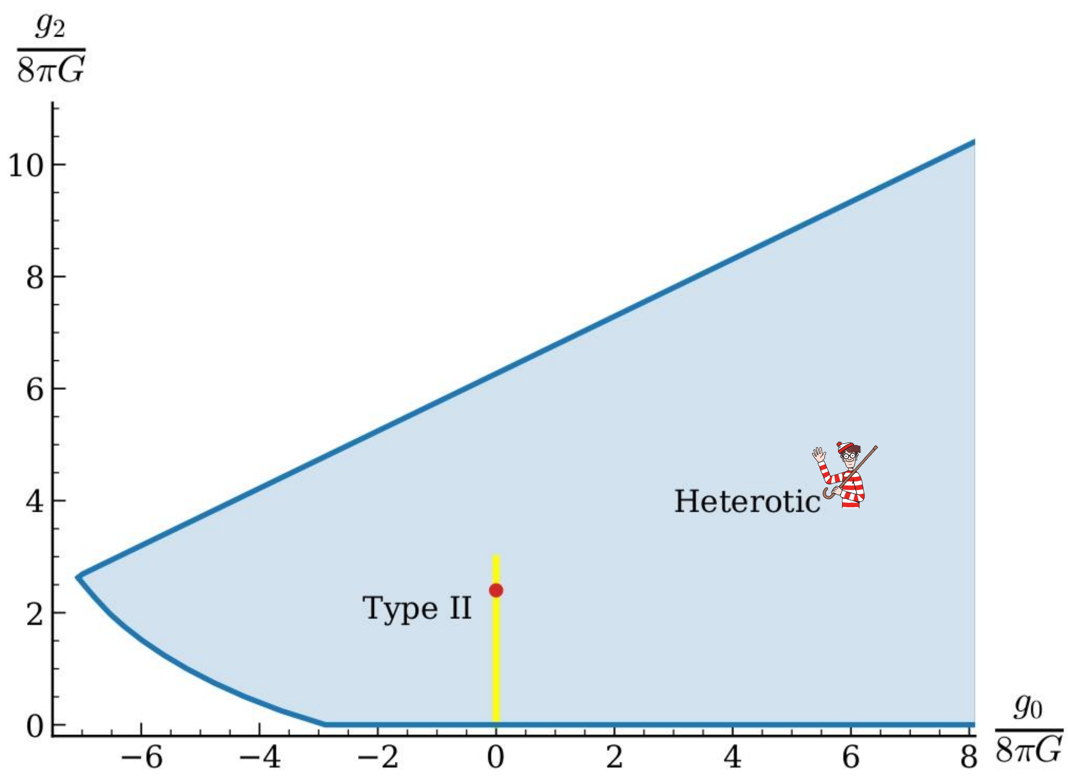

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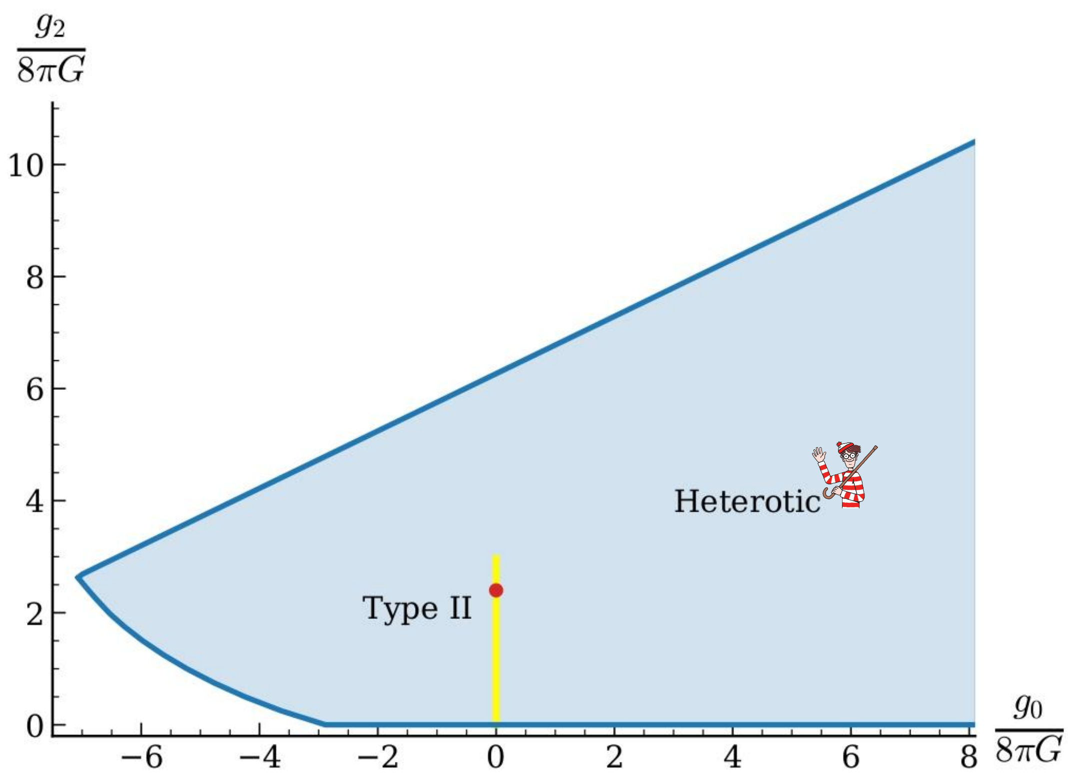

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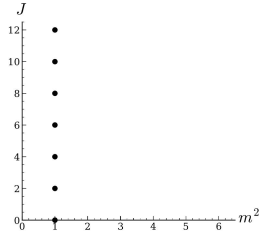
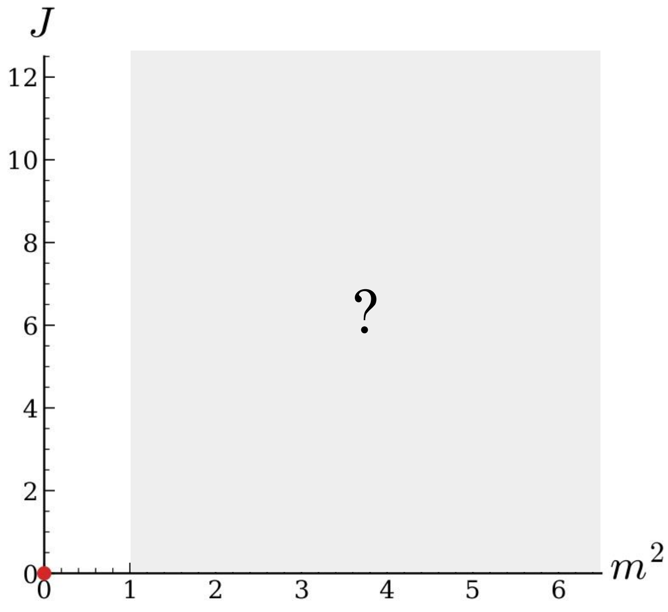


$$\frac{g_2}{g_0} = 0$$

Constraining the spectrum



most general

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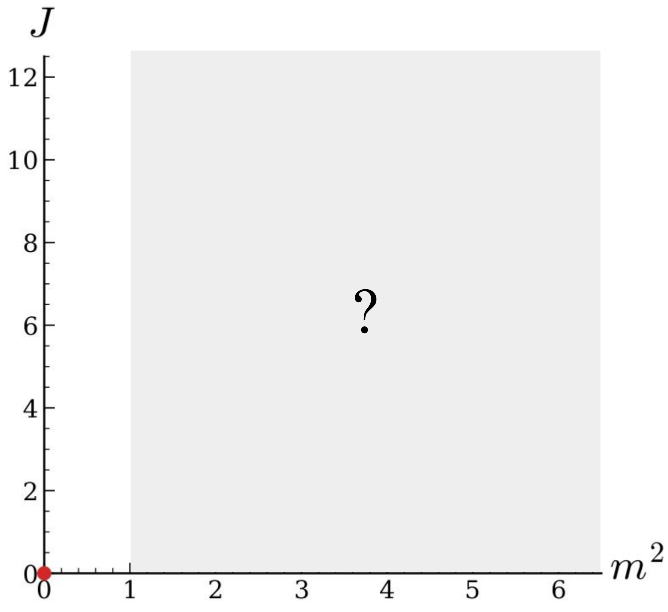

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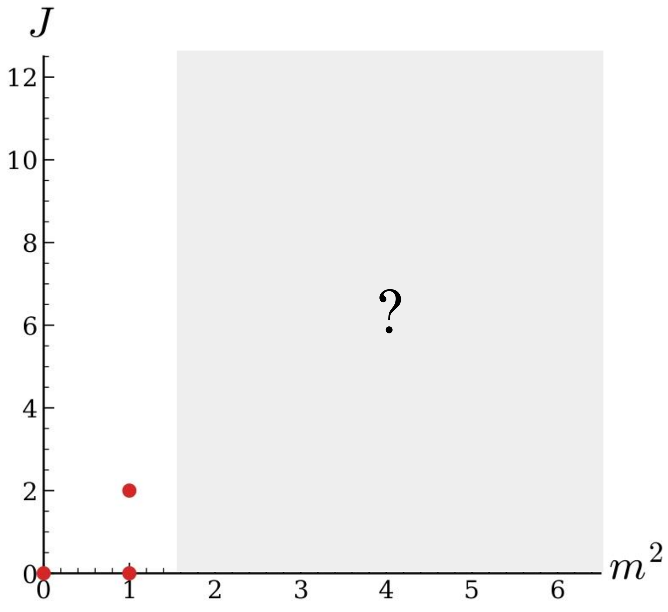
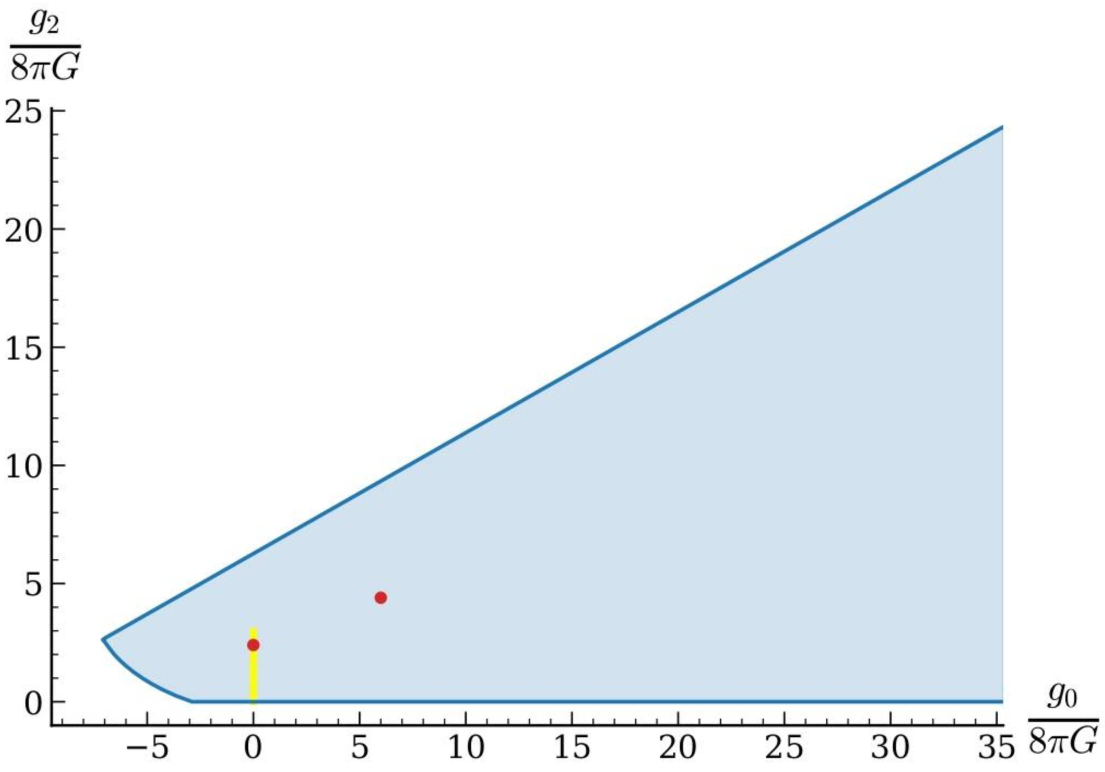


excludes infinite spin tower

Constraining the spectrum

$\mathcal{M}^2 = 1$



Constraining the spectrum

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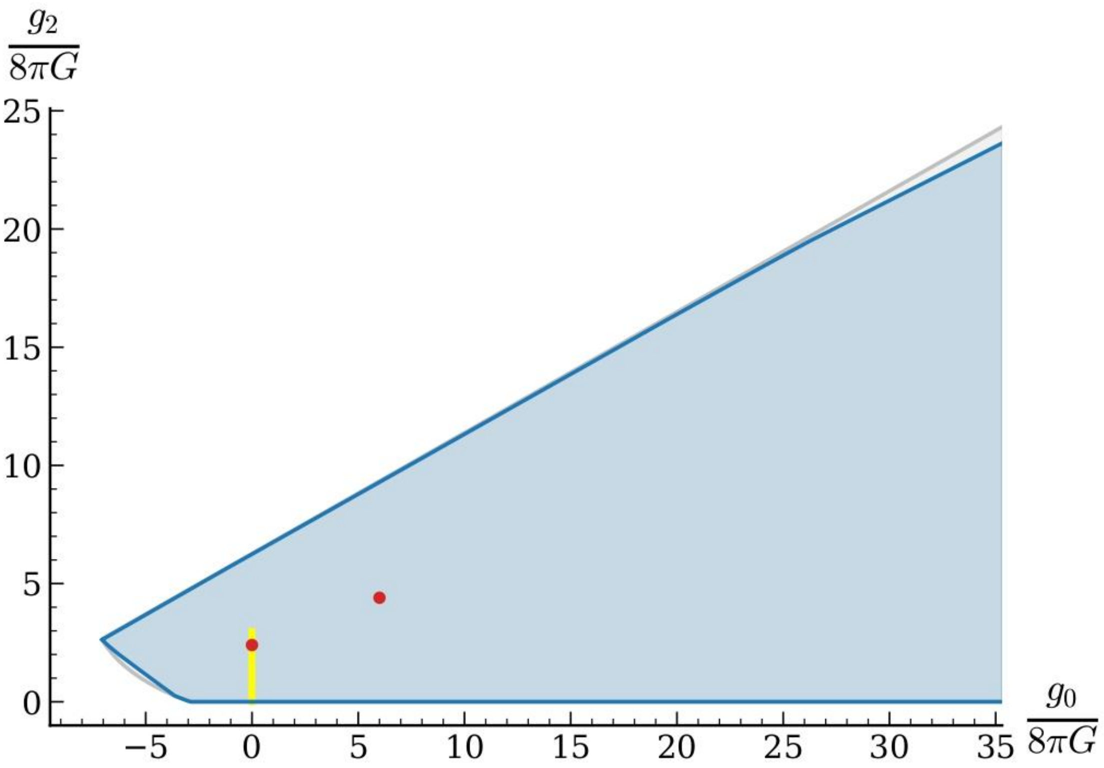

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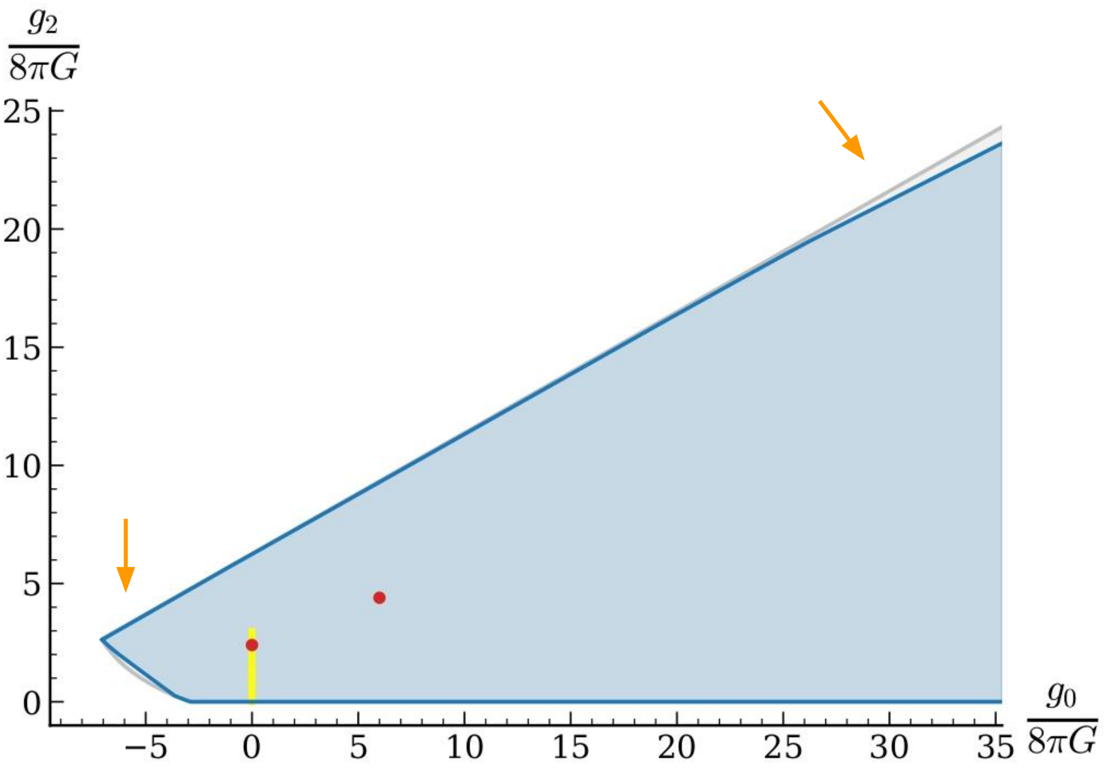

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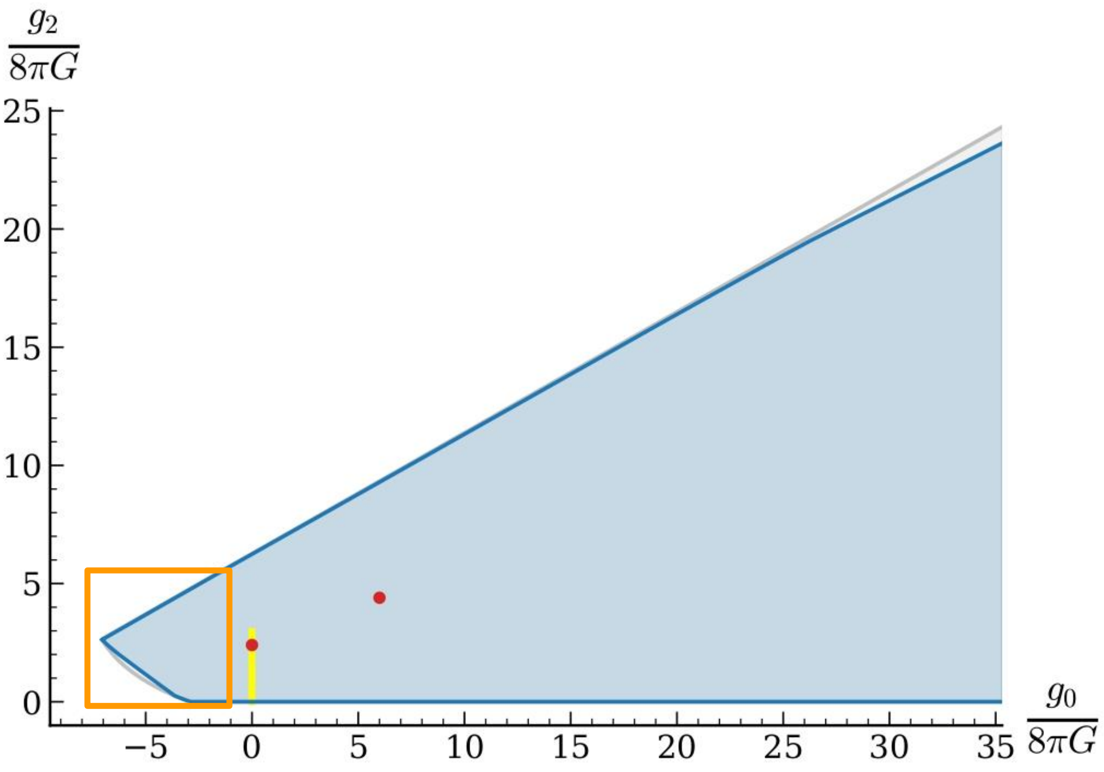
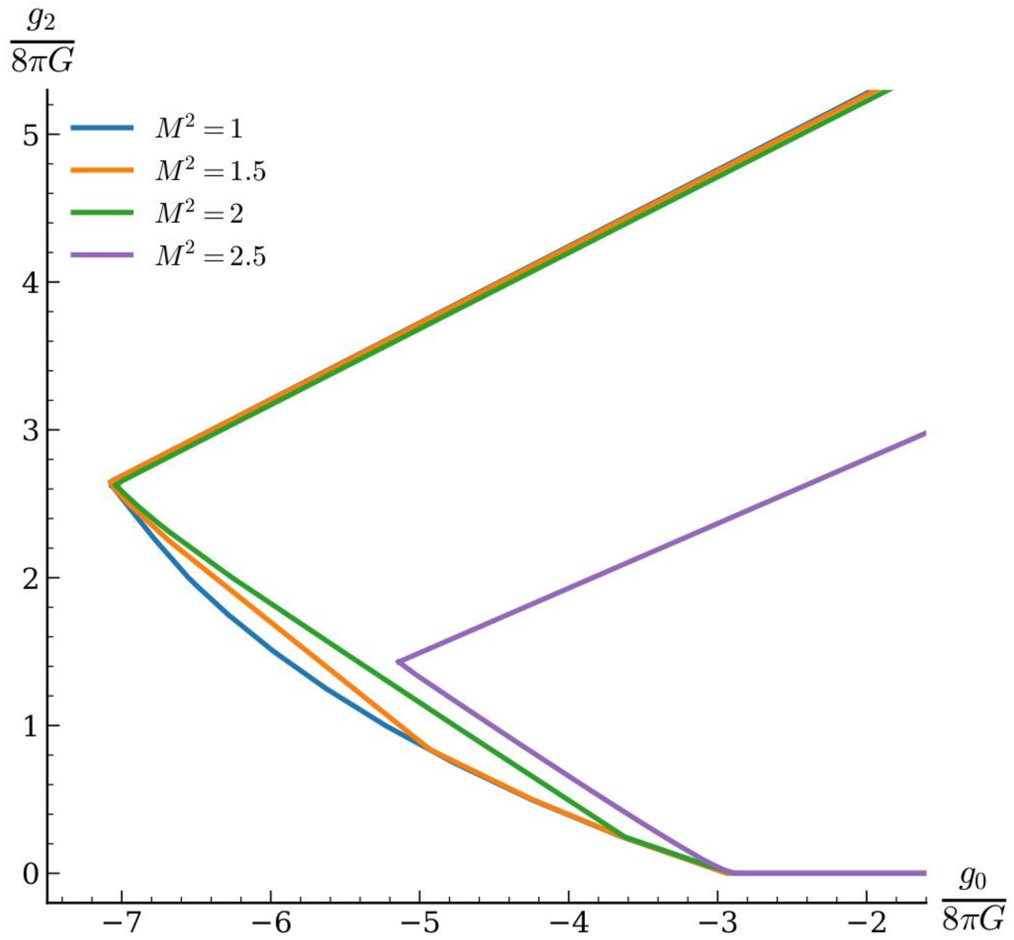


Zoom in: low g_0



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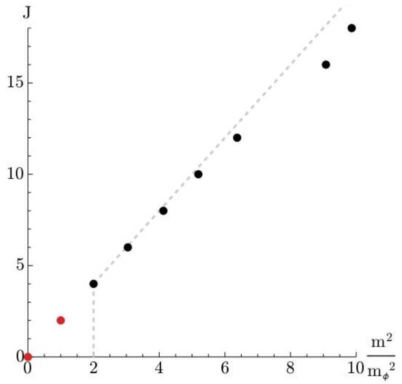

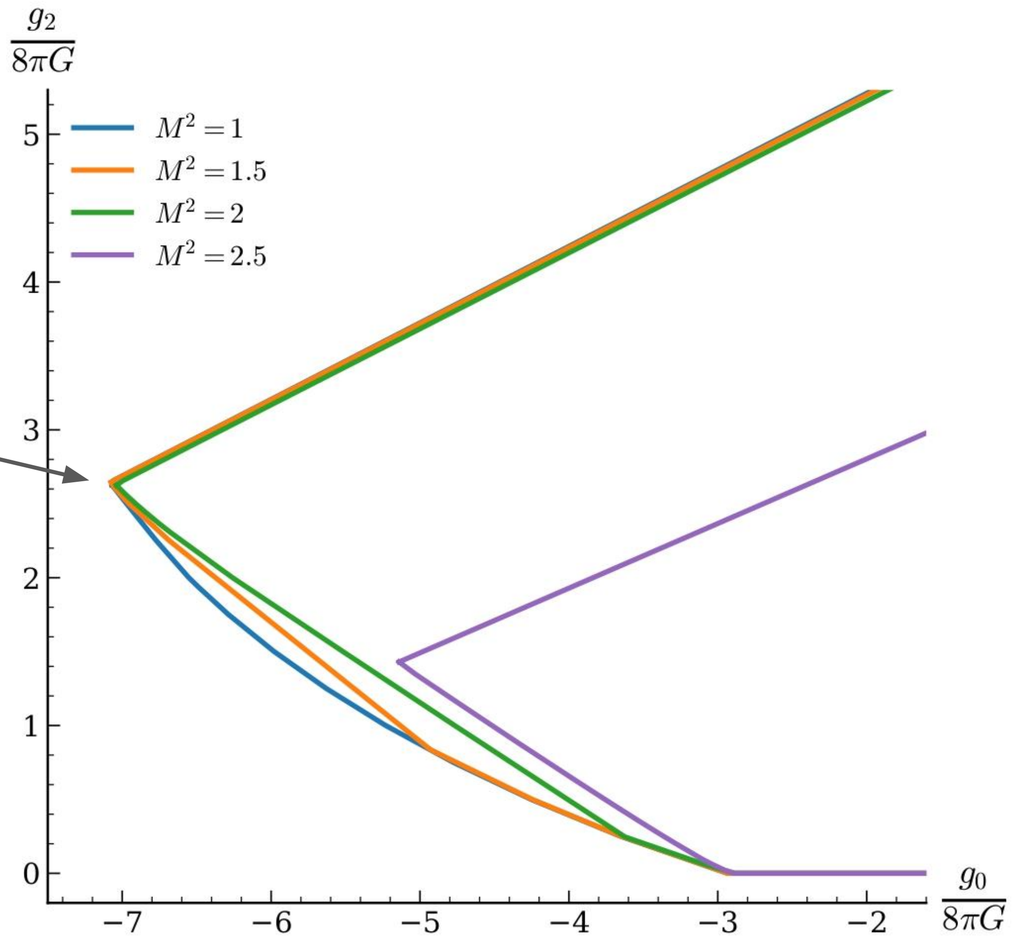

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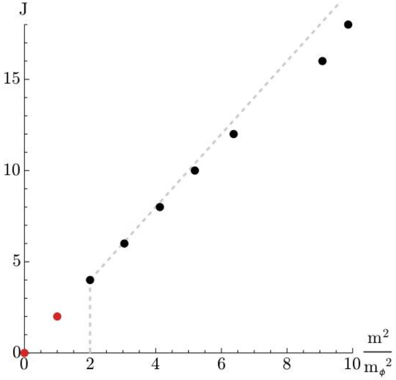

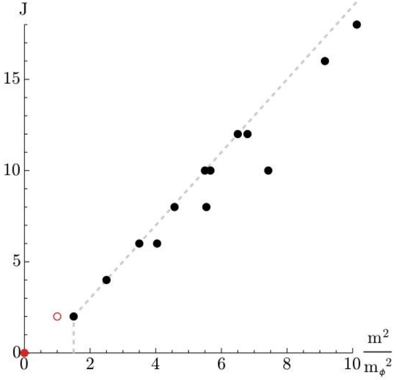

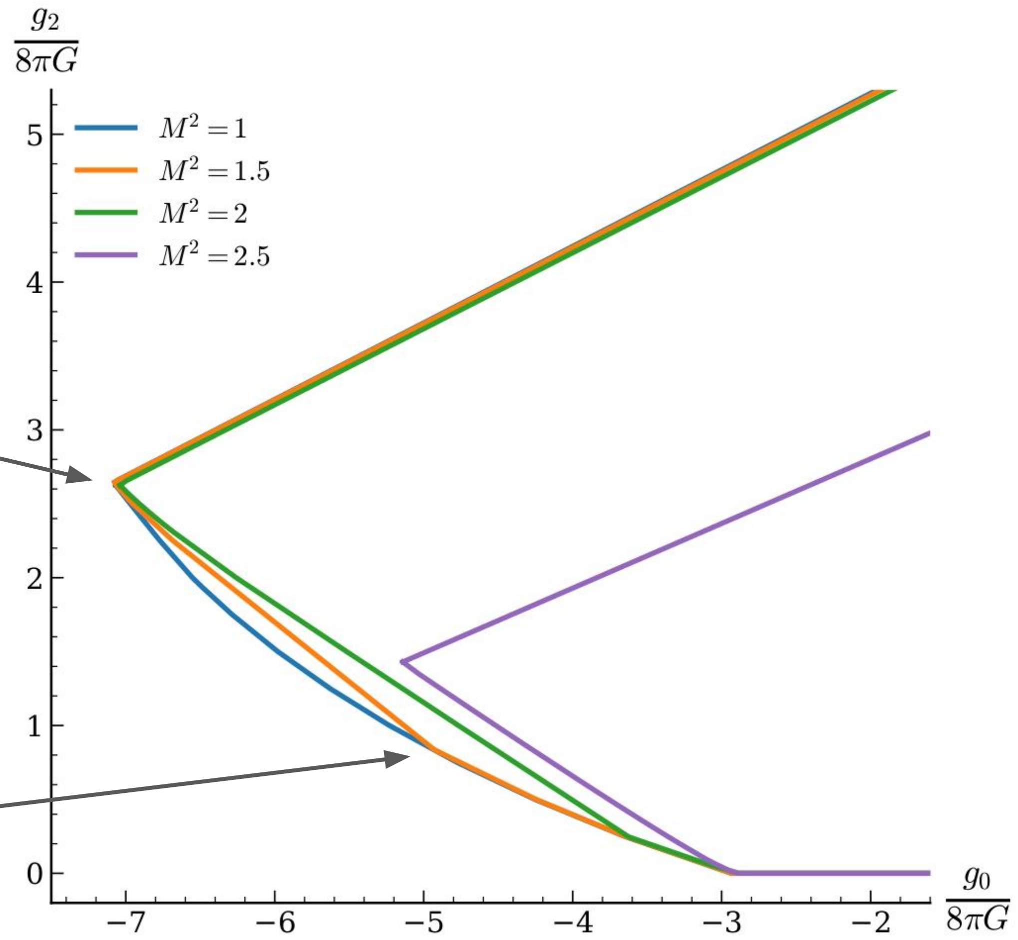

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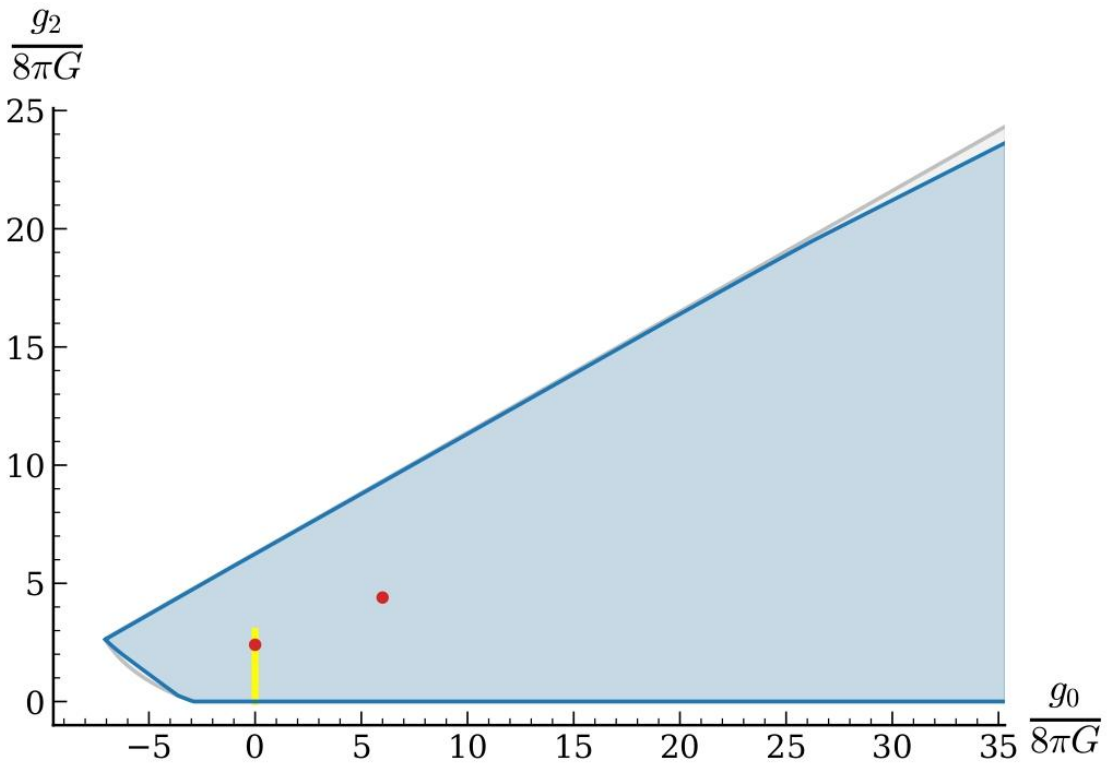

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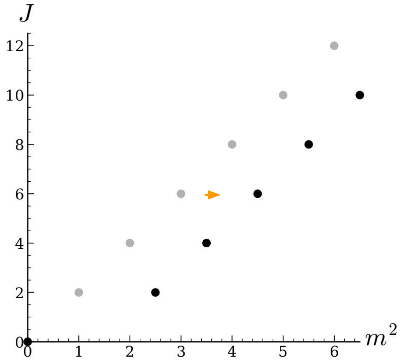

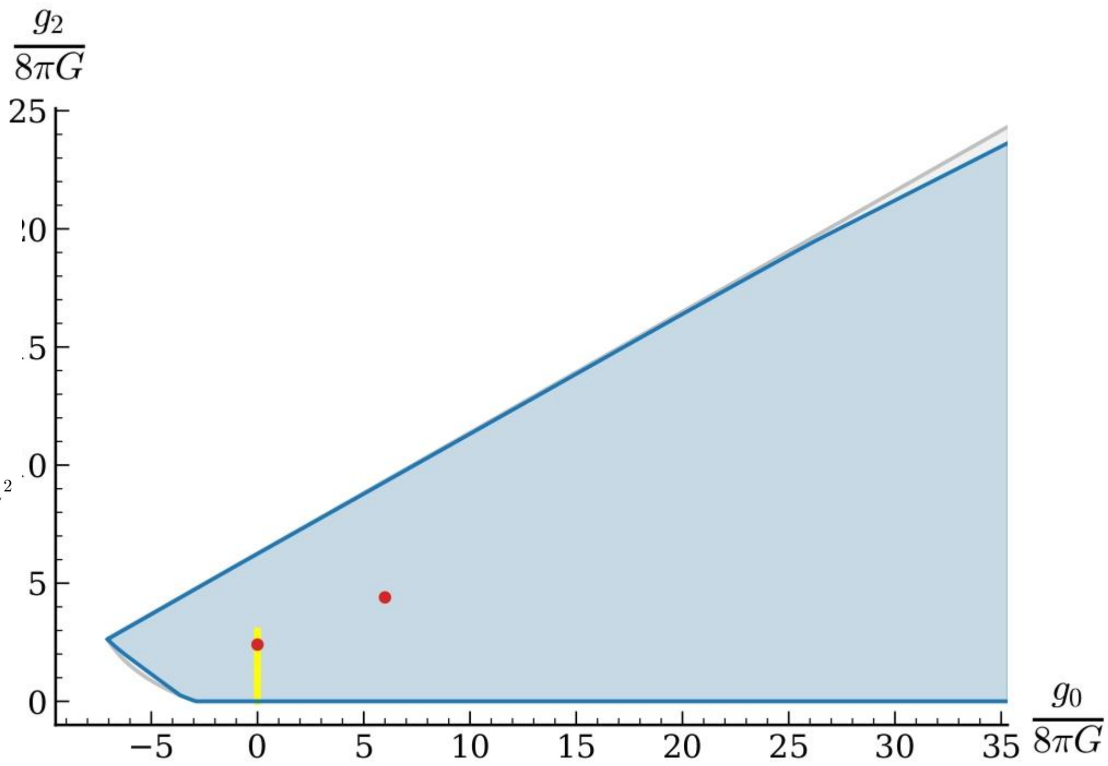

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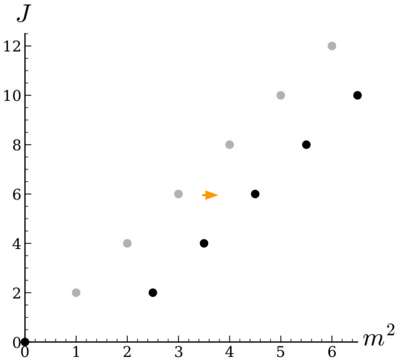
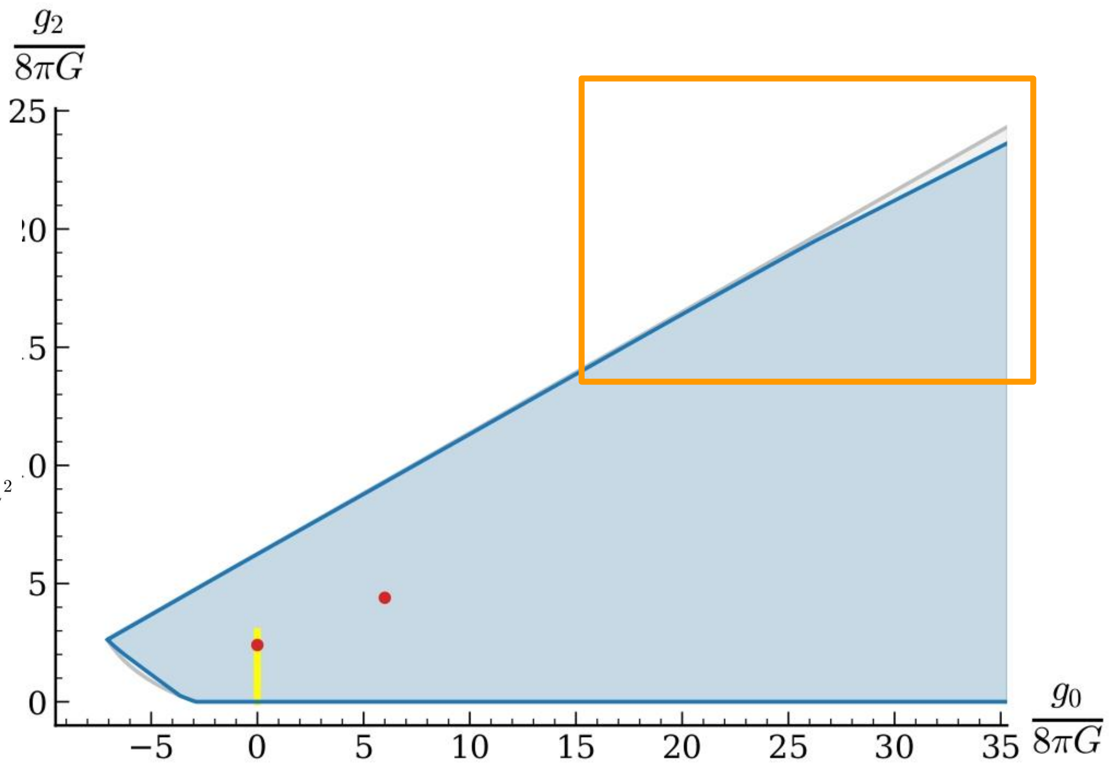
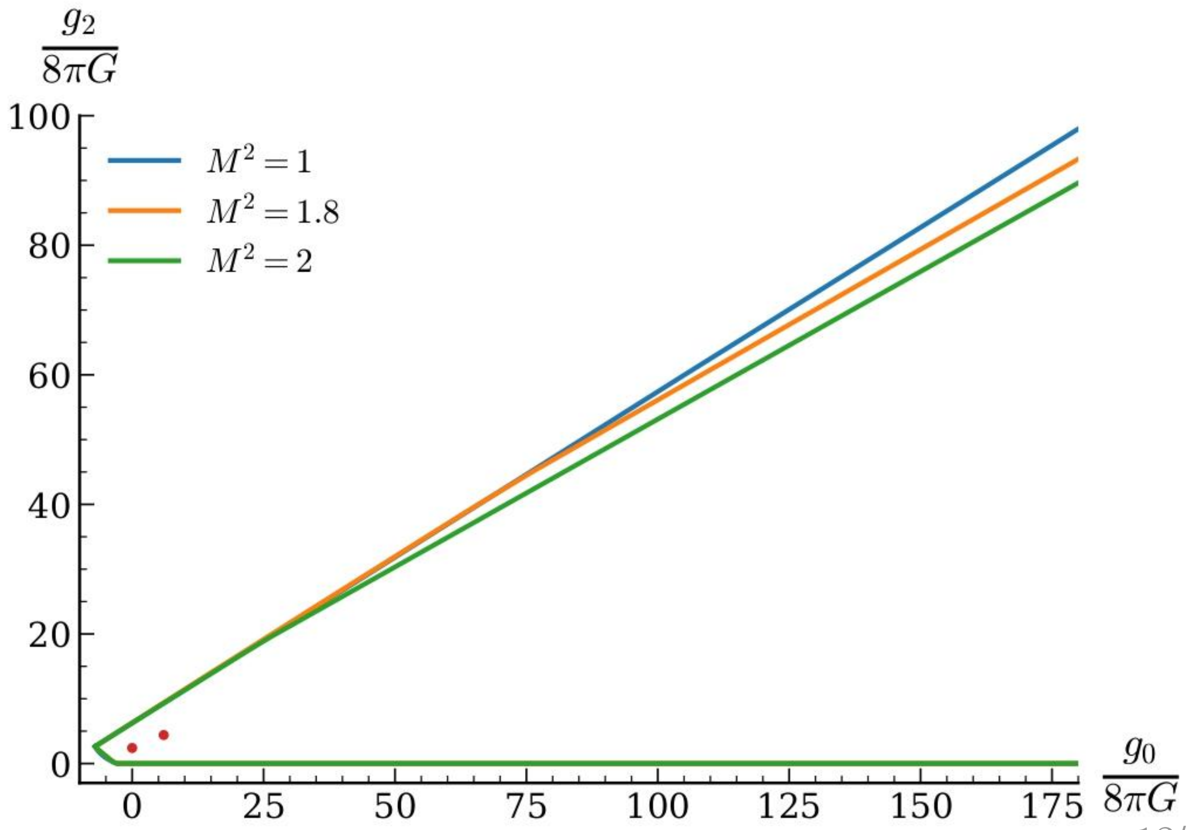




Zoom out: high g_0



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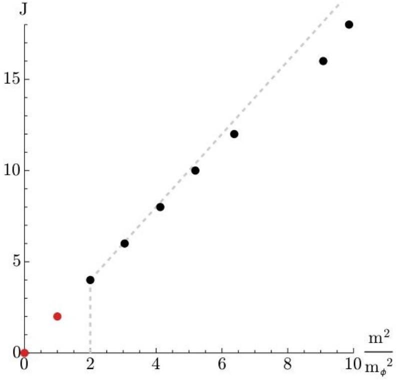

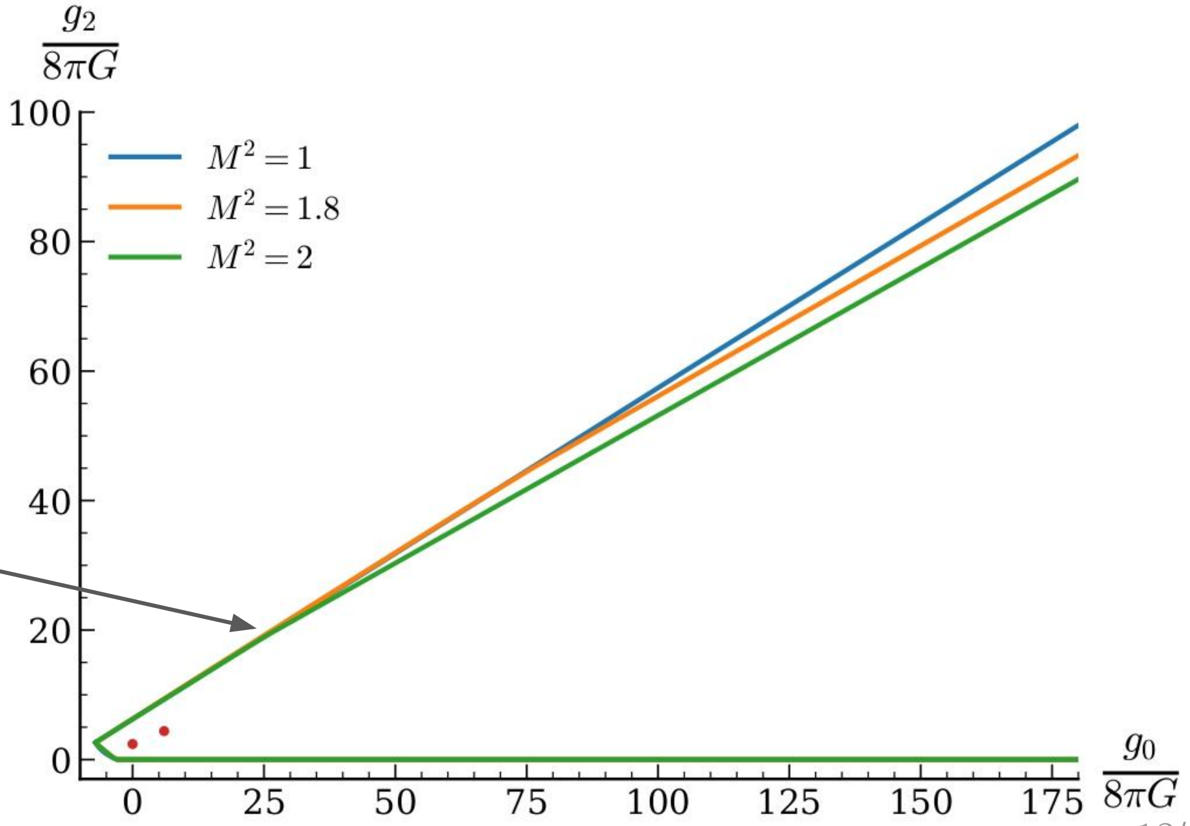

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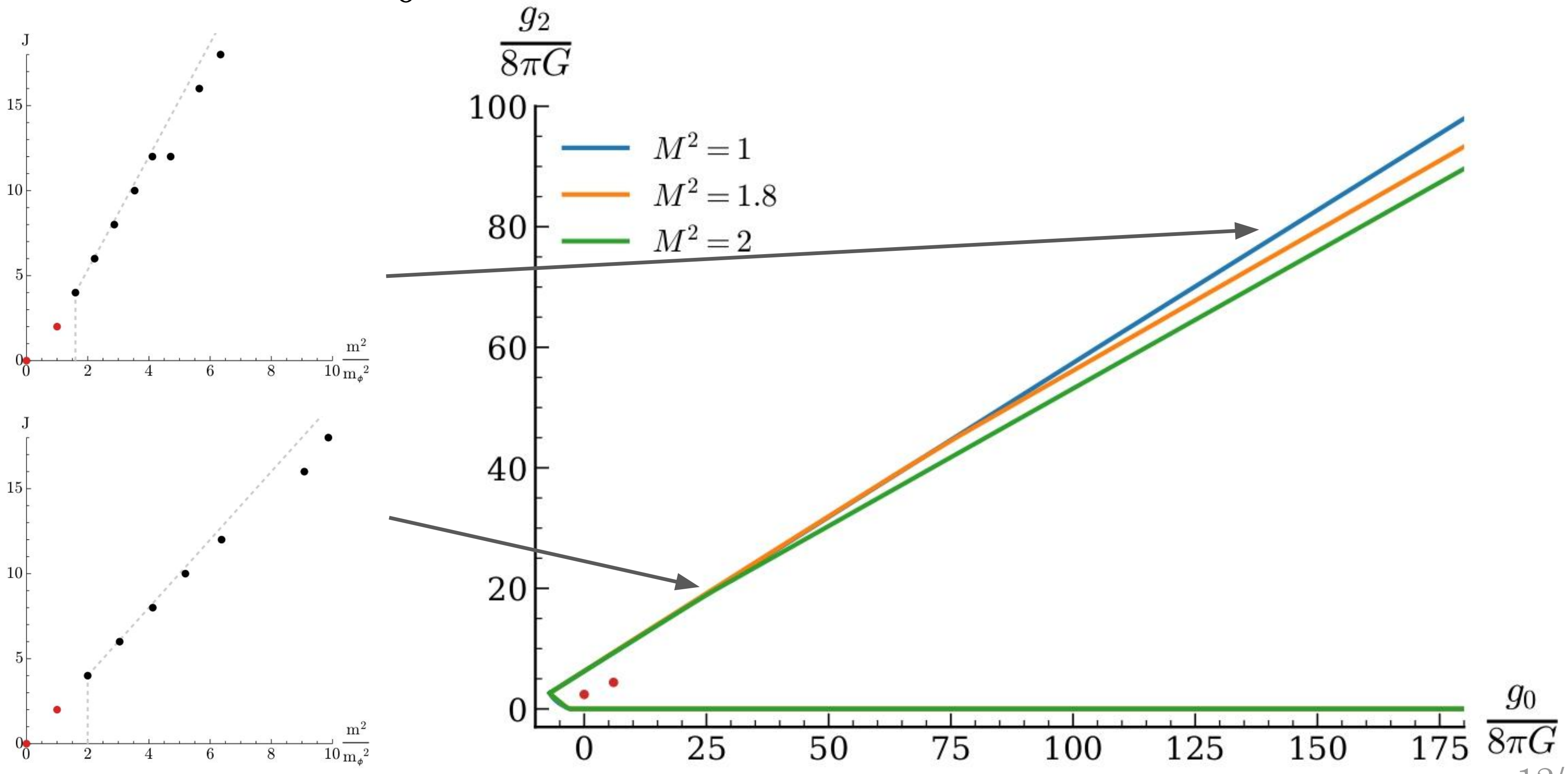
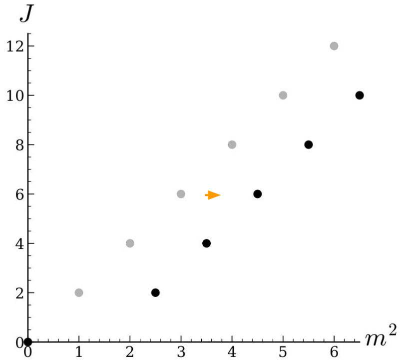
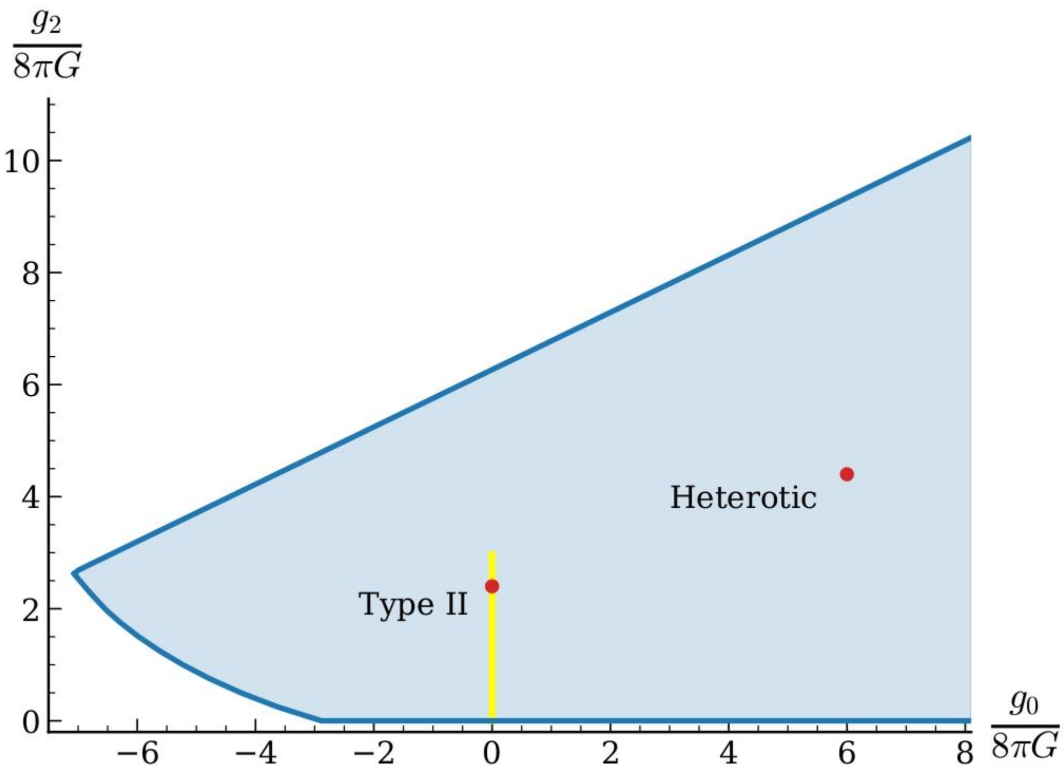


Summary

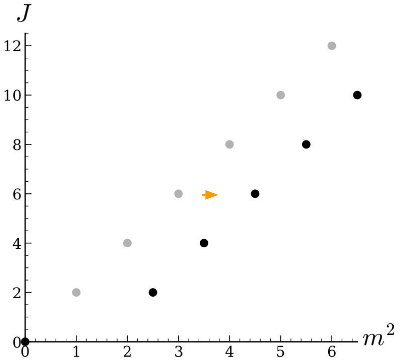


J
12
10
8
6
4
2
0
0
1
2
3
4
5
6
m^2



$\frac{g_2}{8\pi G}$
10
8
6
4
2
0
−6
−4
−2
0
2
4
6
8
$\frac{g_0}{8\pi G}$
Heterotic
Type II

Summary



J
12
10
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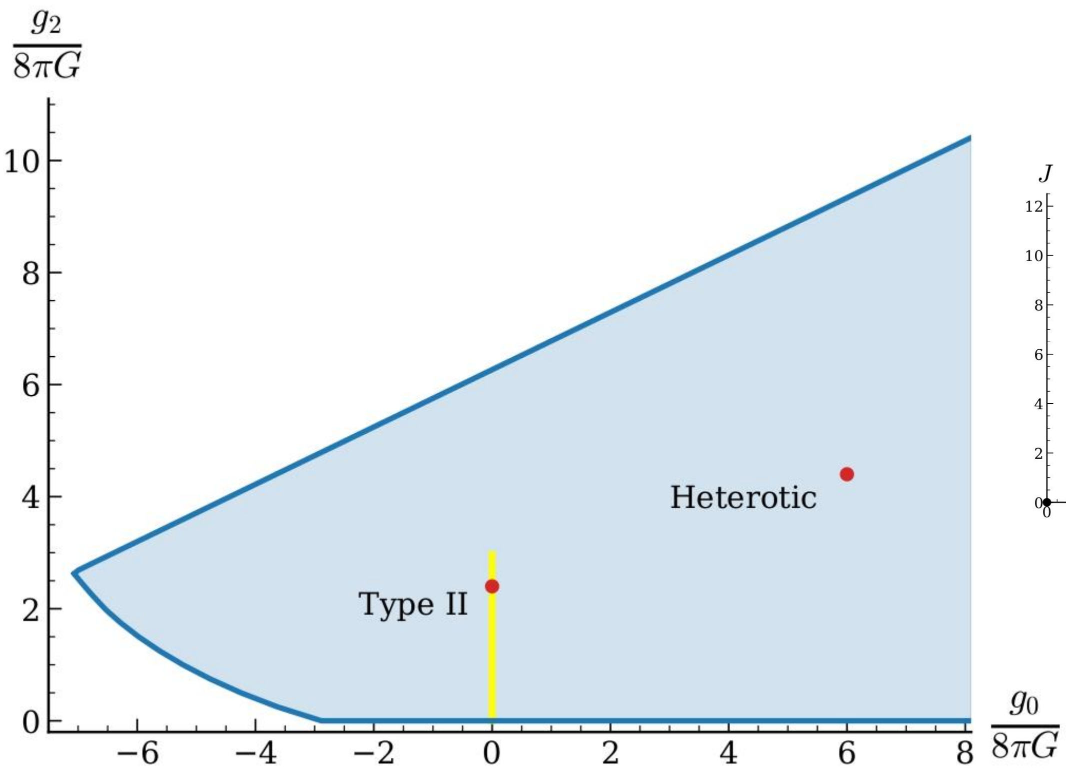
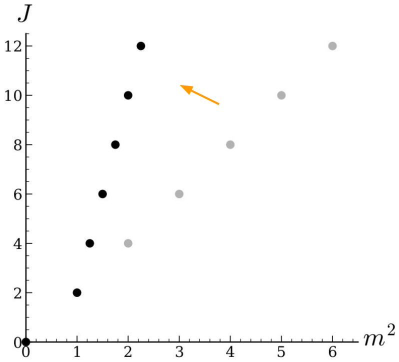
6
m^2

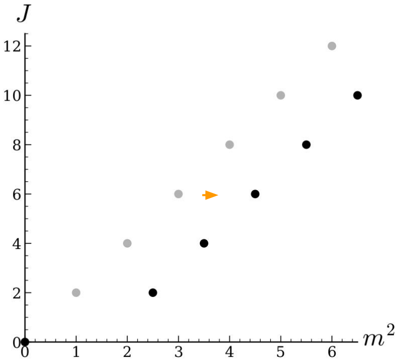


$\frac{g_2}{8\pi G}$
10
8
6
4
2
0
−6
−4
−2
0
2
4
6
8
$\frac{g_0}{8\pi G}$
Heterotic
Type II

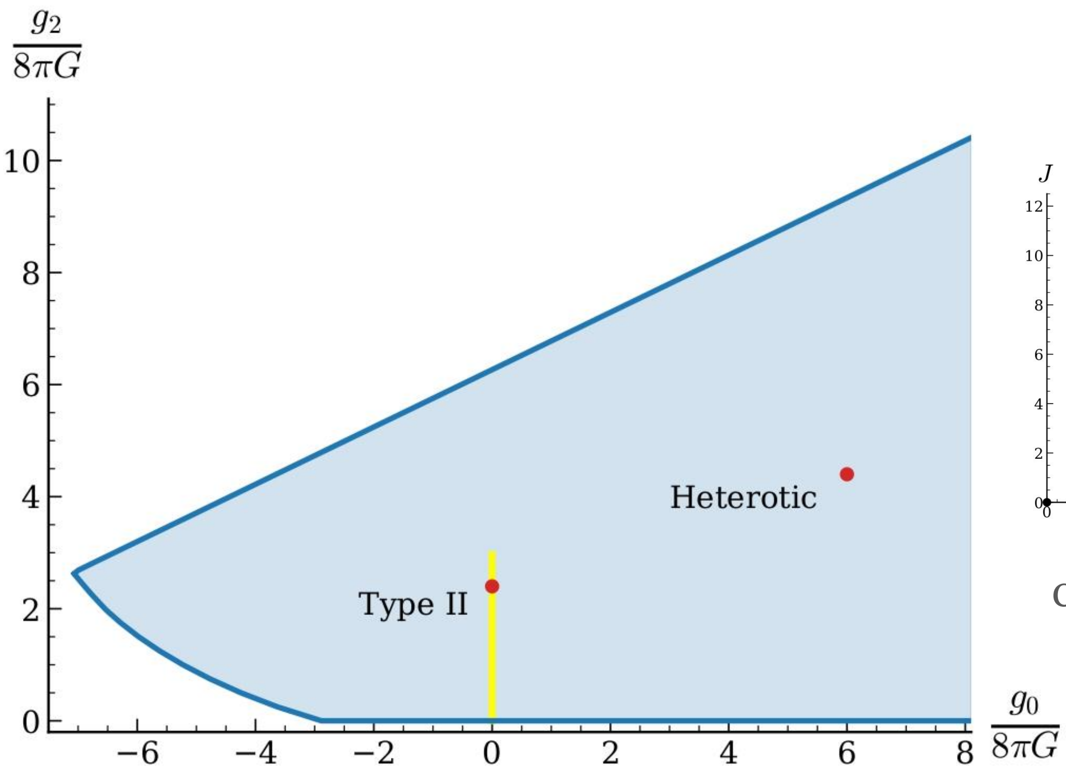


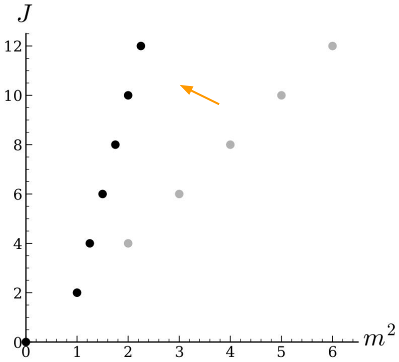
J
12
10
8
6
4
2
0
0
1
2
3
4
5
6
m^2

Summary



cf. closed strings





cf. open strings

Next up: mixed correlators

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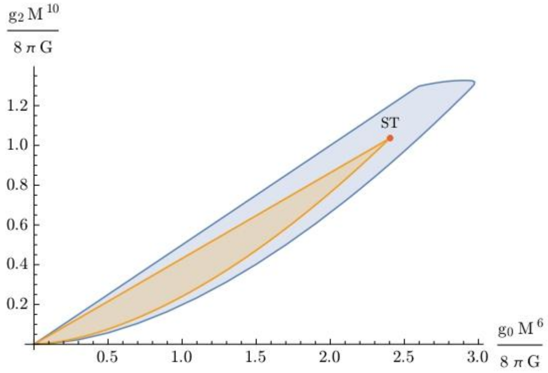
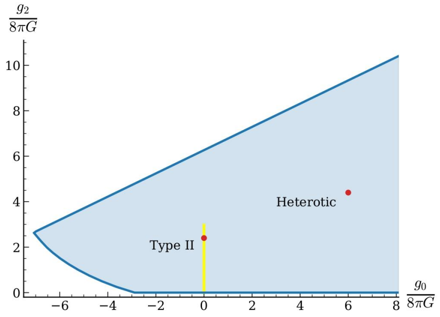
Maximum susy:

gravity + massive scalar

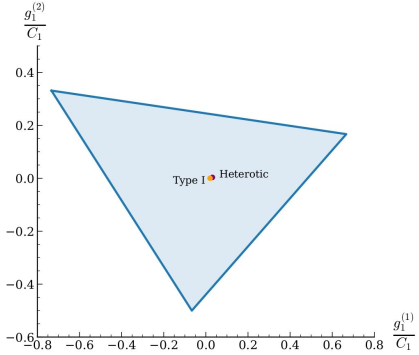


Heterotic:

gravity + gluons



+



Next up: mixed correlators

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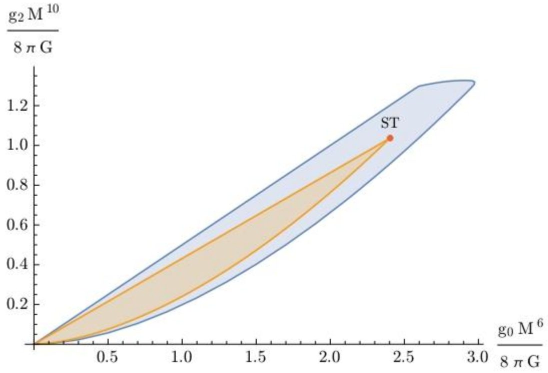
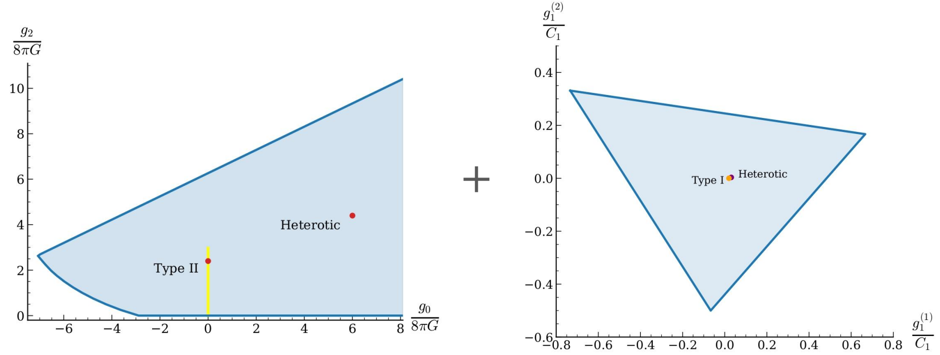


Heterotic:

gravity + gluons



Thank you