

# Kaluza-Klein & Massive Gravity

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# General Relativity

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- GR = Interacting theory of massless spin 2
- QFT + GR  $\rightarrow$  cosmological constant problems:
  1. Why is  $\Lambda$  not huge?
  2. Why is  $\Lambda$  small but non-zero?

# Massive gravity

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- $m_{\text{graviton}} \sim H \sim 10^{-33} \text{ eV}$
- Technically natural solution to 2nd c.c. problem
- dRGT ghost-free theories
  - superluminalities
  - low strong-coupling scale

# Partially massless gravity

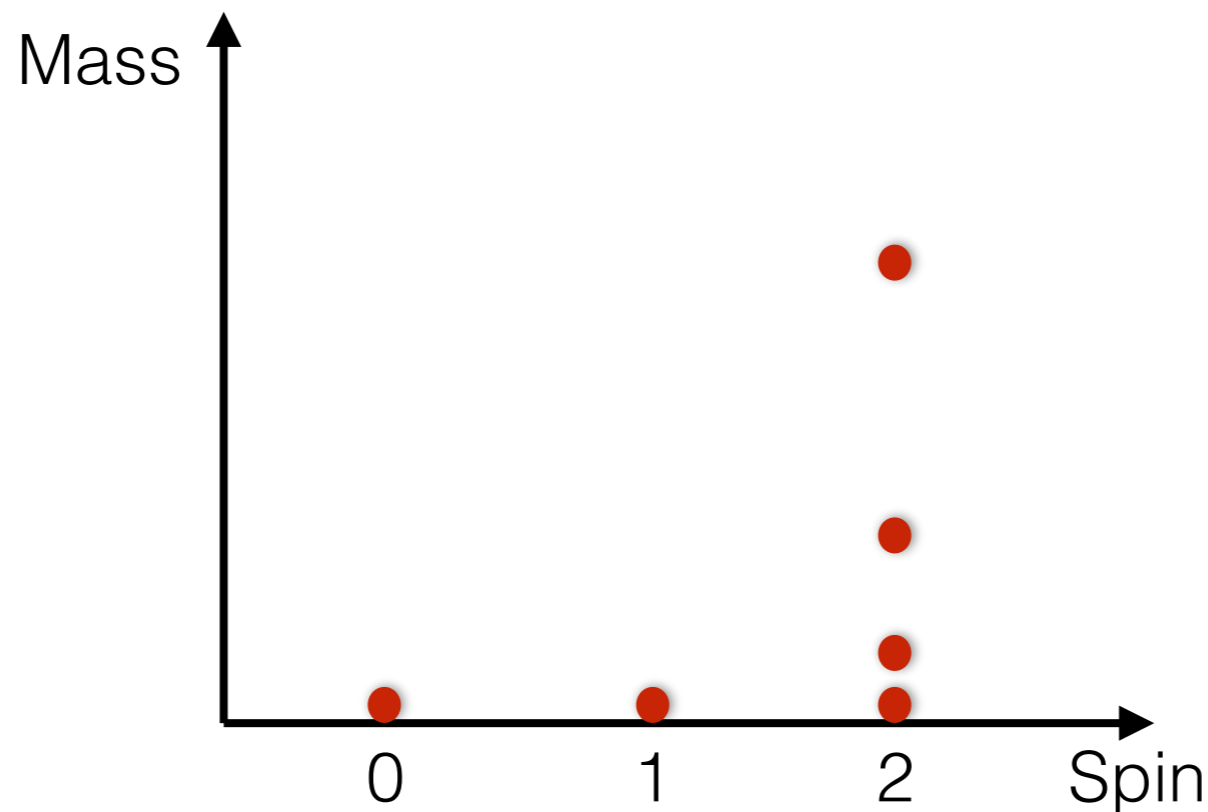
$$m_{\text{partially massless}}^2 = \frac{2\Lambda}{3}$$

$$\delta h_{\mu\nu} = \left( \nabla_{\mu} \nabla_{\nu} + \frac{m^2}{2} g_{\mu\nu} \right) \alpha$$

- Technically natural solution to the 1st c.c. problem
- No helicity 0 mode
- Need a nonlinear theory

# Massive gravity from extra dimensions

- Kaluza-Klein
- 5d GR = 4d GR + Maxwell + massless scalar + infinite tower of massive gravitons



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- Cannot get PM from pure GR
- What about from higher-dimensional massive or PM gravity?

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- Cannot get PM from pure GR
- What about from higher-dimensional massive or PM gravity?
- Also does not work -- PM symmetry does not survive dimensional reduction
- May work with additional structure

# Summary

- Partially massless gravity would be a cosmologically interesting alternative theory of gravity
- We have found obstructions to finding a partially massless field in KK reductions of massive gravity, but extra structure could overcome this