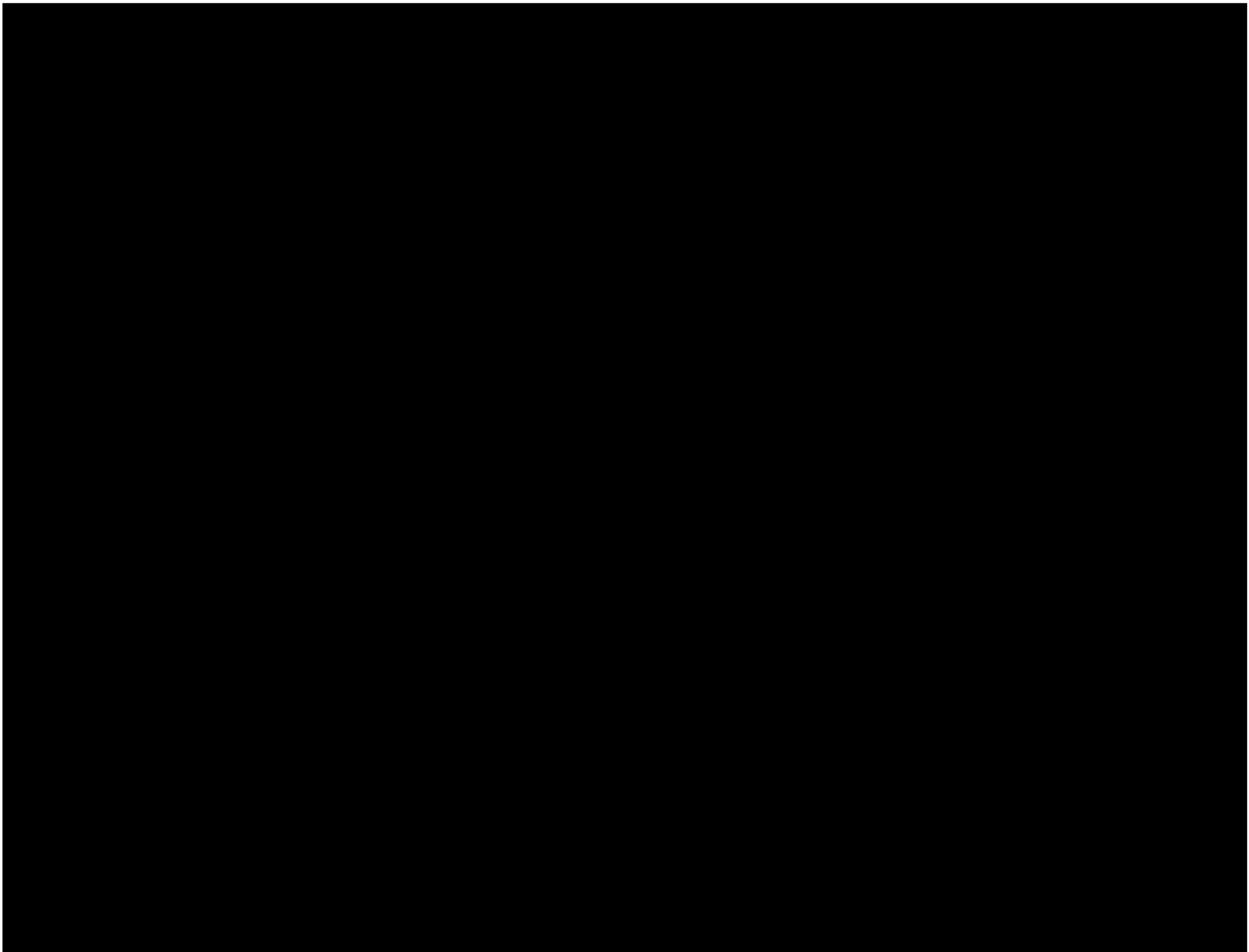


Why Modify?

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So, what do we **really** *know*
about modified gravity?



What do the discussions seem
like most of the time ?

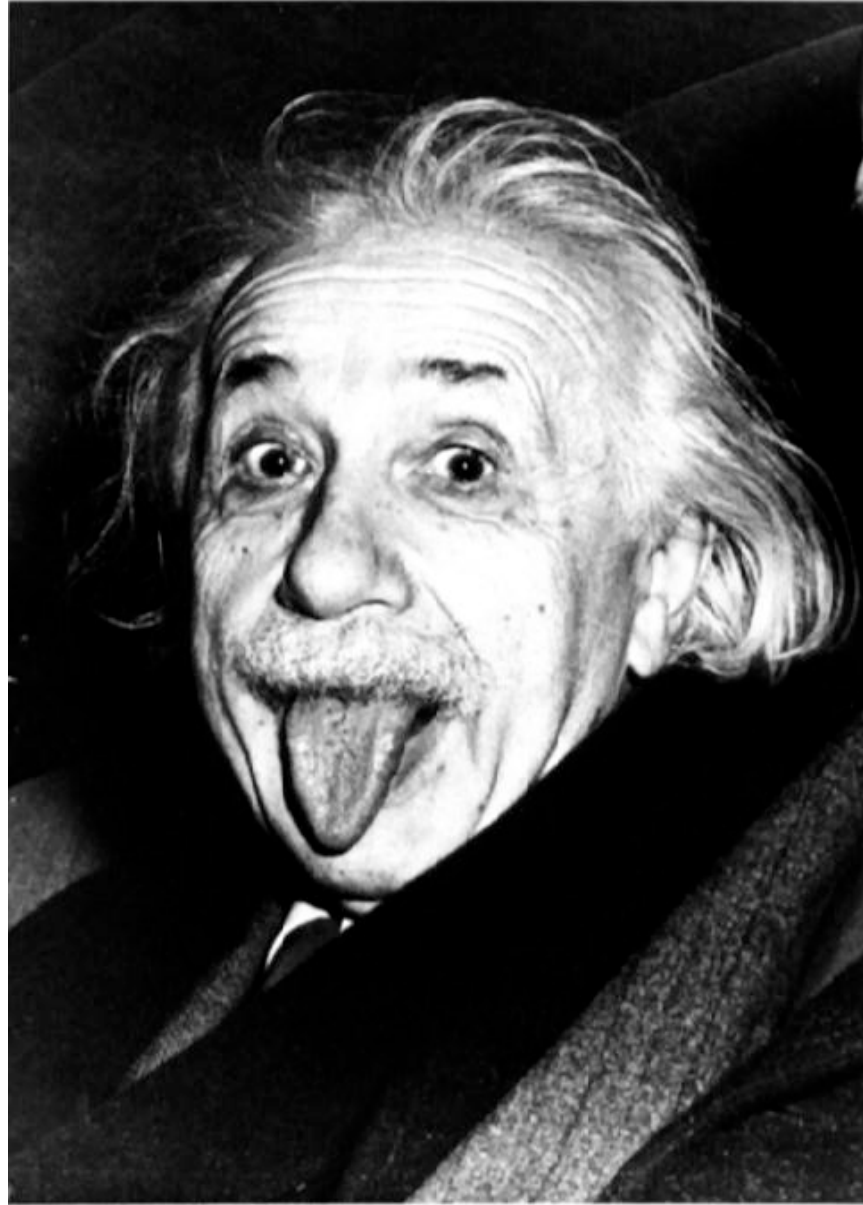
I still don't know what the idea is!

It's about nothing!

... I think you may have something there...



What do our prospects about making sense of it seem like?



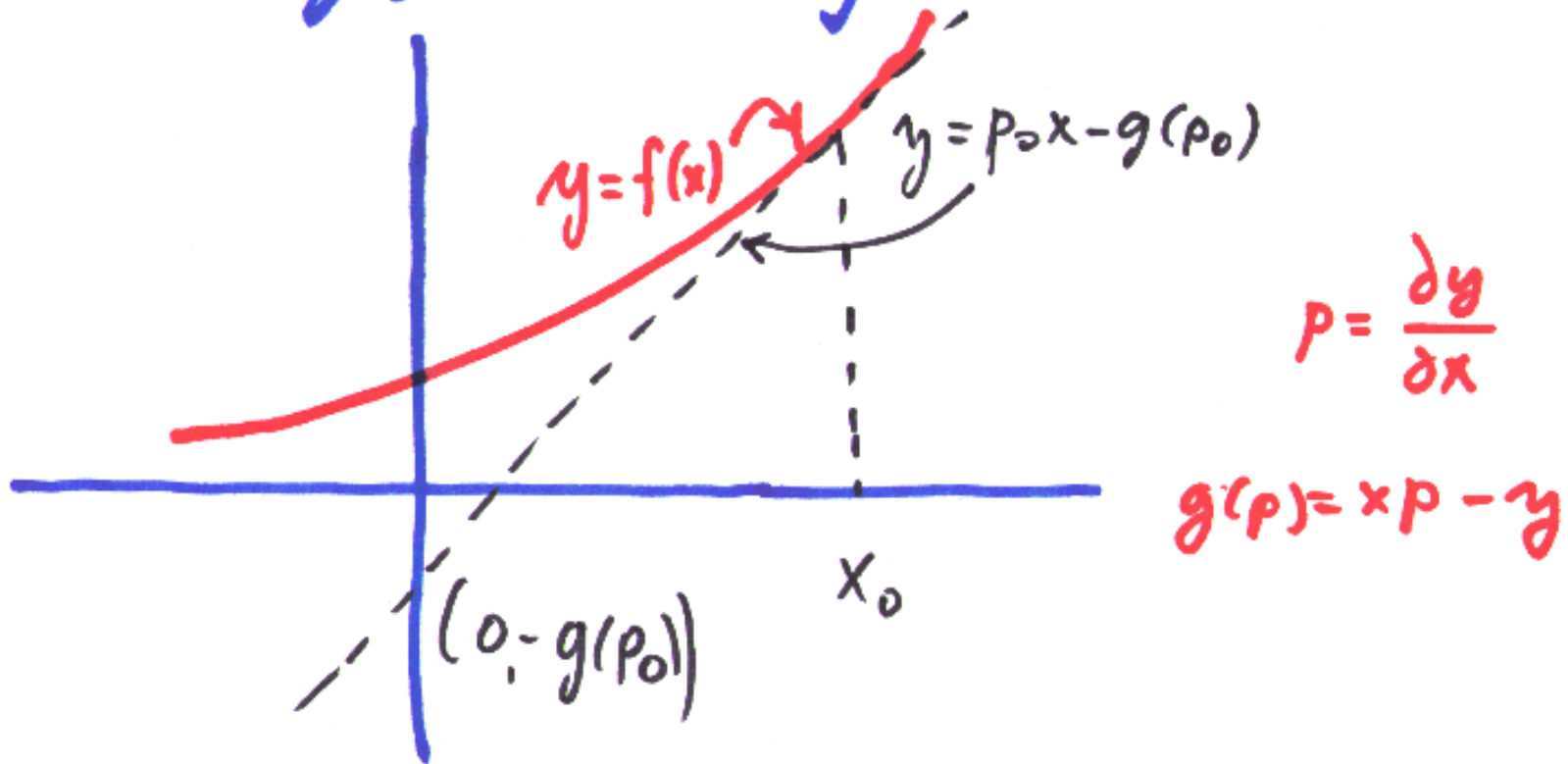
So why do we still try to do it?

*Note that there is **not** a single shred of firm evidence that forces us to do it...*

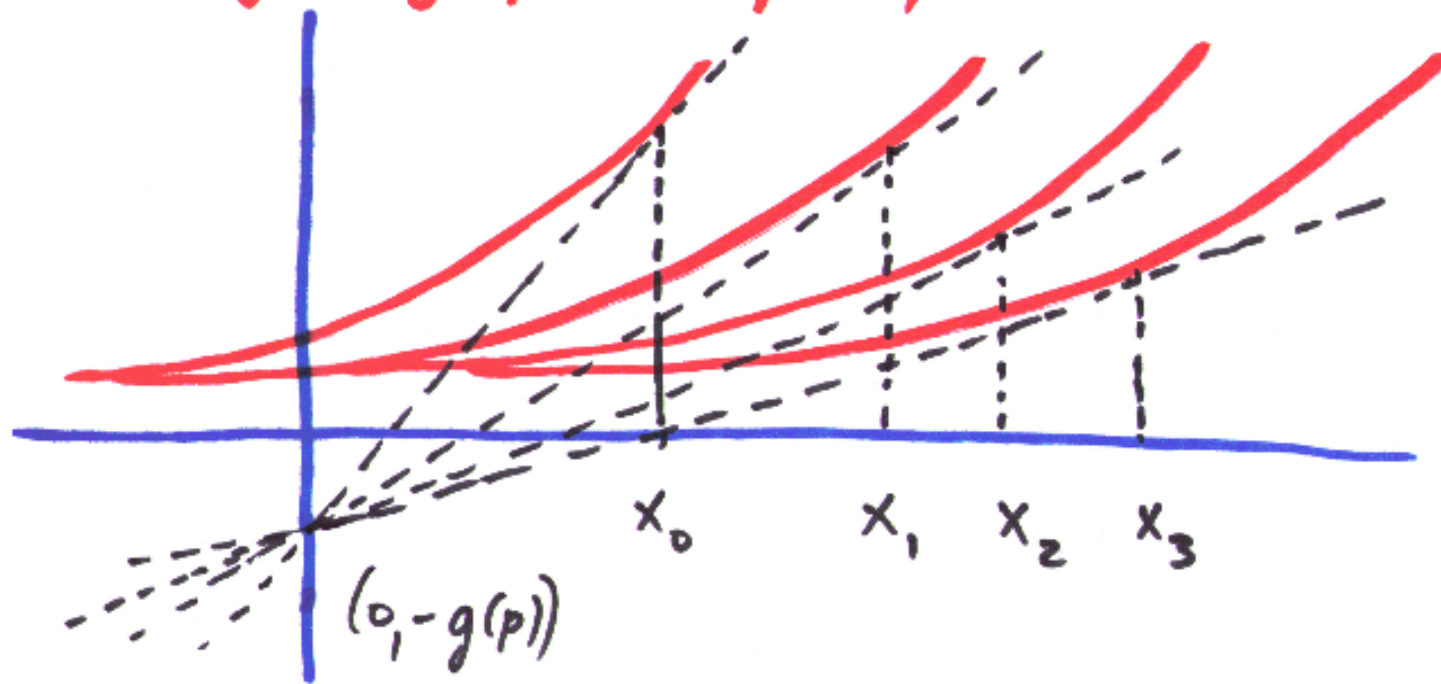
A

Modified gravity v.s. Λ

$\int \sqrt{g} \Lambda$: a Legendre transf.



Now: forget $f(x)$! Can reconstruct it by solving $g(y') = xy' - y$?



Solution not unique if we don't know x_k !

In GR: $x = \sqrt{\det g}$ a nonpropagating pure gauge DOF: can be **ANYTHING!**

Unimodular gravity:

$$R^M{}_\nu - \frac{1}{4} \delta^M{}_\nu R = 8\pi G_N \left(T^M{}_\nu - \frac{1}{4} \delta^M{}_\nu T \right)$$

$$\text{But: } \nabla_\mu T^M{}_\nu = 0 \rightarrow \partial_\mu (R + 8\pi G_N T) = 0 \rightarrow R + 8\pi G_N (T + 4\Lambda) = 0$$

$$\therefore R^M{}_\nu - \frac{1}{2} \delta^M{}_\nu R = 8\pi G_N (T^M{}_\nu + \Lambda \delta^M{}_\nu)$$

$$\Lambda_{\text{tot}} = \langle T^0{}_0 \rangle + \Lambda$$

Motivates the search for a non-standard dynamics with new degrees of freedom...

Note:

- 1) We CANNOT calculate $\lambda_{\text{classical}}$.
That is a BOUNDARY CONDITION
- 2) We CANNOT keep λ_{vac} small.
That is a RADIATIVE INSTABILITY
- 3) We CANNOT link $\lambda_{\text{classical}}$ and λ_{vac} , except by ANTHROPIC PRINCIPLE
This we do not know what it is...

Blessings of the dark curse 😊

- How do we get small Λ ? Is it anthropic? Is it even Λ ? Or do we need some *really weird* new physics?
- A possible strategy: find all that needs explaining, and be careful with your theoretical prejudice (learning to be humble from the story of Λ ...)
- Ultimately, we should really view both precision cosmology and LHC as tests of *naturalness*...

Summary

- Do the successes of GR really demand GR?
 - *If so, we **must** deal with the 'greatest failure' of GR: the Cosmological Constant (perhaps, accept Anthropic?)*
- Benchmarks which can yield alternative predictions to those that support Λ CDM could be useful...
- Maybe new realms of gravity do await? (... but have we tried to look for them in the right way ...)
- But, before setting off on the road of constraining the "theory" with the data, DO make sure it is a theory: i.e. know **what** and **how** to calculate with it (and that it isn't just a trivial form of a known theory in a funny gauge...)