

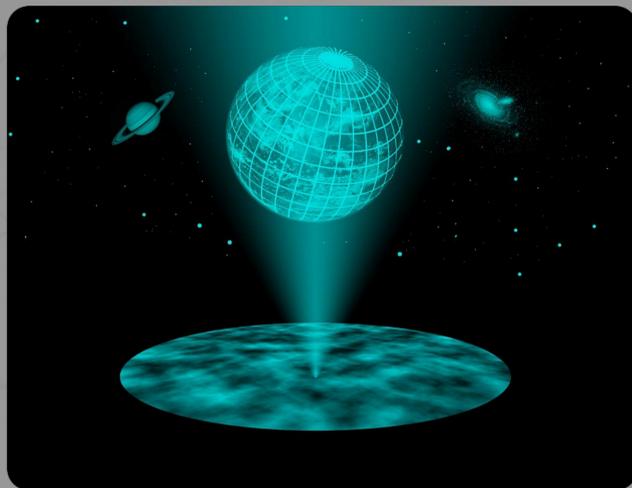
Translate the Universe, please!

1. Holographic principle

The holographic principle means that a **theory of gravity** may be mathematically equivalent to another theory **without gravity and in one dimension less**. Once you have a precise description of one of the two theories, there is a way to obtain a precise description of the other theory. To do this you need a specific **dictionary** that tells you how things in one theory translate into the other.

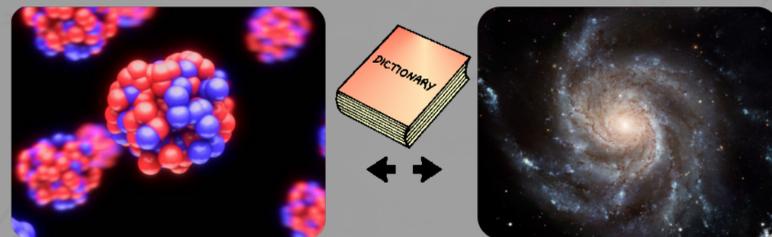
2. The world as a hologram

Imagine that our **three dimensional world** could be described by another theory akin to electromagnetism or the nuclear force in **only two dimensions**. Although there is "much more space" in three dimensions than in two, everything we want to know about our 3D world could be encoded in the 2D twin theory.



3. Why is it useful?

Some theories in physics are really hard. For example, certain tiny particles attract each other so strongly that you cannot disentangle them, not even mathematically! The holographic principle tells us that we can solve a different, easier problem instead and then **translate the results** back to the hard problem using the **holographic dictionary**!

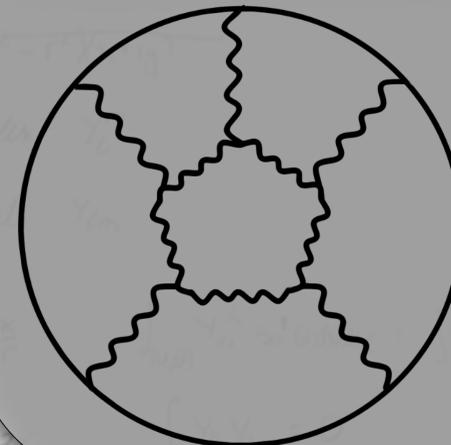


4. My contribution

The focus of my research consists of enlarging the holographic dictionary, and improving our knowledge of the theories it connects. The idea of my current project is simple: because of the correspondence we can compute the same thing in two different ways, directly, and indirectly using the dictionary. The point is that in some cases certain quantities on one side of the correspondence can be computed exactly, but look very complicated from the point of view of the other side. In the setting I am looking at, I have good knowledge of the non-gravitational lower dimensional theory (depicted on the left side of the picture above) and of the dictionary. In the gravitational theory on the right side there are some unknown parameters. The correspondence and exact results on the non-gravitational side allow me to obtain knowledge about these parameters and to confirm the holographic dictionary.

5. For the experts

The quantities that I mentioned in the previous paragraph are correlation functions in a supersymmetric quantum field theory, and some of them are determined by symmetry arguments. The unknown parameters of the gravitational theory are the so-called coupling constants. These couplings tell us how strongly particles interact with each other. Because computations on the gravity side are complicated, to get an overview, one represents them by pictures, the so-called Witten-diagrams, named after their inventor Edward Witten. These Witten-diagrams are the basic building blocks that I am trying to compute.



6. Conclusion

My research aims at improving the fundamental understanding of holographic theories. Once concrete results are obtained, they can be applied to different areas of physics, such as particle physics, cosmology, black holes or superconductivity, to perform computations and to obtain predictions that have never been seen before. To know more, try scanning these QR codes!



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