How to make the most isolated object to see the beginning of Universe

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My research topic is to isolate a macroscopic object from all external disturbances.

To show you how hard that is, let me ask you a quick question. Please consider this:

how would you keep an object, such as block, completely still?

First, you hold it in your hands and try not to move even holding your breath. But even then, the object will move by several millimeters, despite your effort. Next, you might place the object on ground and avoid walking around to prevent vibrations from reaching it. However, this can still fail because the ground is always moving, even when there are no earthquakes. The amplitude of this motion is on a micrometer scale. If you are familiar with how a seismometer works, you might recall one of its components: suspended mass and a recording surface. Because the suspended mass responds slowly to external vibrations, we can treat it as being isolated from high-frequency motion.

Can we say the suspended mass is completely isolated from external force? The answer is No. Even if we place it in vacuum to eliminate air flow, it is still connected by a wire. As mentioned earlier, seismic motion may not significantly affect the suspended mass itself, but interestingly, the wire still moves.

This is due to “Thermal motion”. More precisely, the particles make up the wire are fluctuating unless the temperature is at absolute zero. This effect is unavoidable, and it is a major obstacle in many high precision experiments. So, the goal of my experiment is to establish the method to suppress the influence of thermal motion by combining multiple measurement records.

Then, we face a fundamental question: why is keeping the object perfectly still so interesting? The reason is that isolating a mass leads to future space-missions. Surprisingly, I study the method to isolate mass to learn about the beginning of the Universe. One such experiment is a space-based gravitational wave detector.

A gravitational wave is a ripple in space-time that travels across the universe. Its effect appears as a tiny change in the distance between two freely floating masses. This change is incredibly small—comparable to the shift in distance between the Earth and the Sun by the width of a hydrogen atom. To detect it, we must place two masses in perfect isolation from their environment and precisely measure the distance between them.

Earlier, we considered how to minimize the motion on Earth, but the most effective approach might be to perform experiments in space. In space-based experiments, the mass is not suspended by a wire, so external forces, like ground vibrations and thermal noise from the suspension system, do not interfere with the measurements. Ultimately, it may even be possible to detect the primordial gravitational waves, which were generated during the birth of the Universe. This is the reason space-based gravitational wave detectors are especially exciting.

As you can imagine, space experiments are extremely expensive and complex. Since we usually have only one chance to launch, we have to carry out many demonstration experiments on Earth. And this is exactly where some of the most

important and difficult challenges remain. Remember, the main reason we turn to space-based experiments is that we have not yet succeeded in making still environment on Earth. Therefore, it took ten years and several million dollars to launch the demonstration satellites for the space-based gravitational wave detector. If we could reduce thermal effects and replicate an environment as still as space on the ground, we would be able to save this cost!

You might be wondering what to think of all this. The idea that distortions in spacetime could reveal the beginning of the universe might sound like a SF story. To be honest, I feel that way too. But the reason I continue my research in this field is that I can actually test these ideas. "Studying the beginning of the universe" really means designing equipment and doing hands-on experiments. I can use my own hands to uncover a world that's hard to believe. That is the biggest reason I love this field.

I want to share some knowledge and experiences that might help you on your journey, whether it’s in science or something else.

First, always ask questions about everything. As you learn more at school and later in university you will come across many new concepts. When that happens, try to check whether they make sense compared to what you already know. If something doesn’t feel right, don’t be afraid to ask questions or talk it over with others. There

have been many times when I couldn't figure something out for days, but it was solved instantly just by asking someone.

Second, practice expressing your thoughts clearly and confidently. In science, and in most areas of life, communication is one of the most important skills. Especially in experimental science, there are many different stages, and many people involved, planning the experiment, designing and building equipment, management the schedule, analyzing data, and writing reports. For large-scale projects, such as space-based experiments I mentioned before, you will work with more people from different fields and organizations. To lead and collaborate effectively, you need to present your ideas clearly and be open to feedback. The only way to get better at this is through practice, so take every chance to speak, write and share your ideas.

Finally, no one knows where the next big idea will come from. Please dedicate yourself to what truly interests you. That interest doesn't have to be limited to studying, it can come from experiences in many different fields. Stay curious and you may discover something amazing.

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