



## Popular science summary of the PhD thesis

PhD student	<u>Lara Baalbaki</u>
Title of the PhD thesis	<u>Stochastic Inverse Problems: Stability, Correlation-based Data, and Multi-Resolution Methods.</u>
PhD school/Department	<u>DTU COMPUTE</u>

## Science summary

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Modern science often tries to understand things we can't see directly, like what's happening deep inside the Earth, inside the human body, or in far-away stars. To do this, we measure what we *can* observe on the outside and try to work backwards to figure out what's happening inside. Problems like this are called **inverse problems**. They appear in many fields: using earthquake waves to study the Earth's interior, using telescopes to study distant galaxies, or using CT and MRI scans to look inside the body.

But in the real world, the information we collect is never perfect. Measurements contain noise, and our mathematical models don't fully capture reality. This thesis develops new mathematical tools designed to deal with this uncertainty rather than ignore it.

The key idea is to use a flexible mathematical framework that describes how information gets blurred, sharpened, or filtered as it moves through a system, a bit like understanding how different camera lenses affect a photo. This helps us understand what the data can actually tell us, and what it cannot.

The thesis answers three main questions:

1. **Can we learn what's inside a region just by measuring at the boundary?**

Yes, and not only can we recover the hidden source, but we can also learn about its average behavior and how much it varies. The results guarantee that small measurement errors won't completely ruin the reconstruction.

2. **Can far-away measurements still reveal information about a random, "noisy" source?**

Surprisingly, yes. Even if waves travel a long distance, the way they correlate with each other still contains enough information to recover how the hidden source fluctuates.

3. **Can we sharpen blurred data without blowing up the noise?**

The thesis introduces a new "multi-resolution" method that sharpens data differently in different areas, for example, very sharp where details matter, smoother where they don't, while keeping the entire process stable so that noise doesn't get amplified.

In short, the thesis provides new, reliable mathematical methods for turning imperfect data into trustworthy information. These tools can improve imaging and detection in areas such as medical diagnostics, studying the Earth, and inspecting materials without damaging them.

Please submit the summary to the department PhD coordinator together with your thesis