Dynamic sparse X-ray tomography

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January 30, 2015

Why *sparse* tomography?

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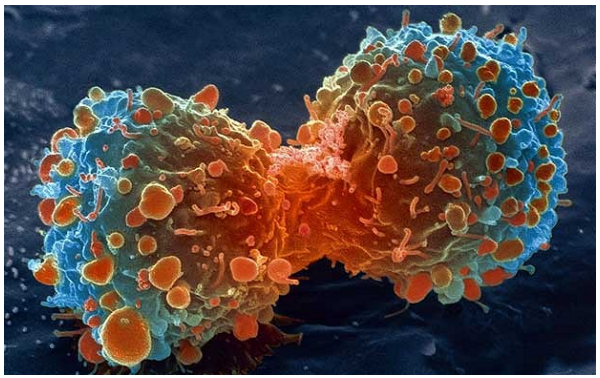

X-rays contribute to cancer development.

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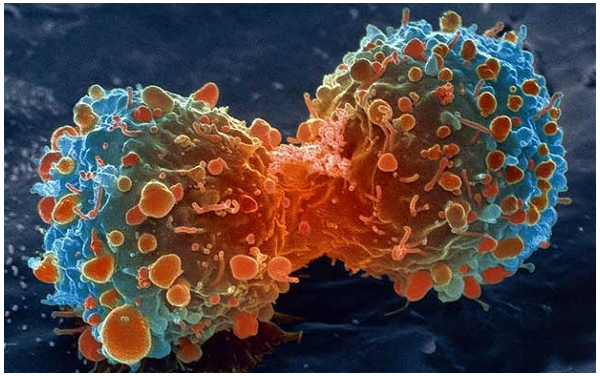

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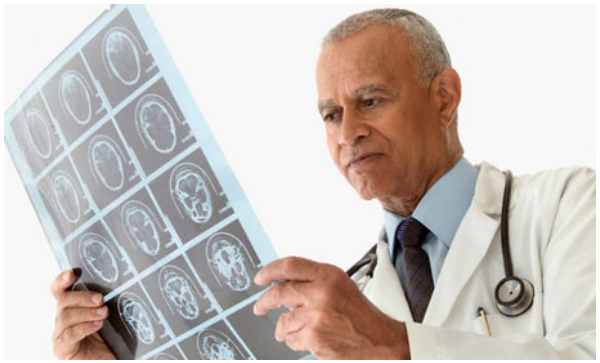

Prevention as early diagnosis.

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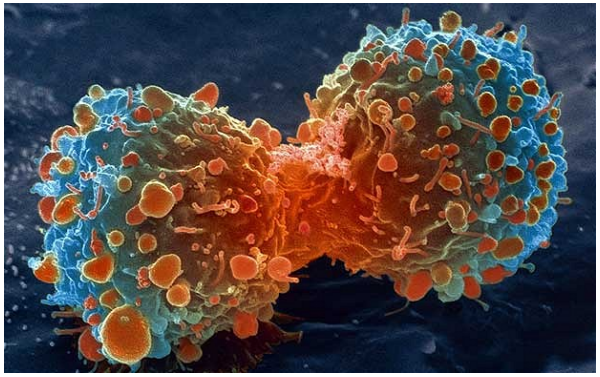
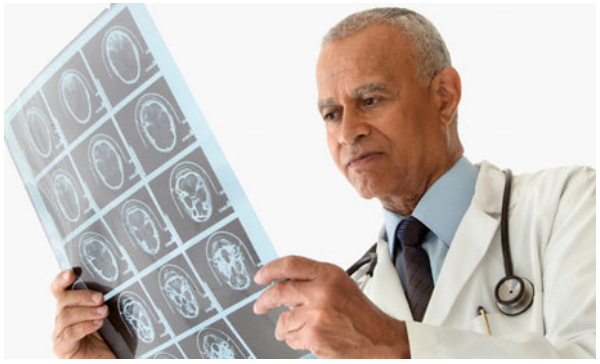


X-rays contribute to cancer development.

Save time and money.



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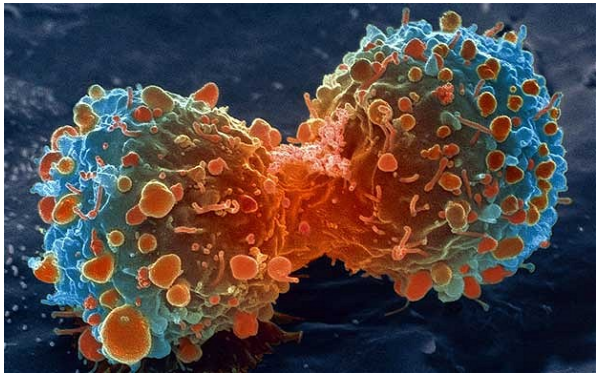

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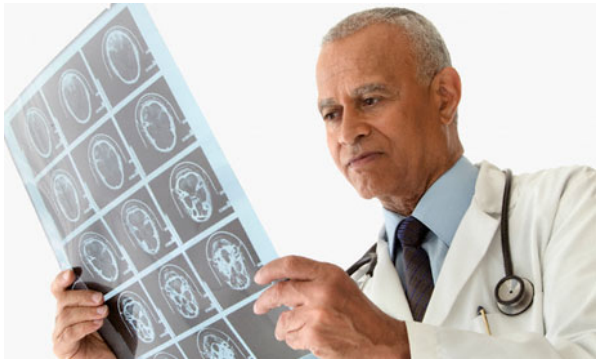

Prevention as early diagnosis.

Material testing.

Why *dynamic*?

For instance:

- angiography

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- angiography
- veterinary

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- angiography
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- monitoring reaction to cancer medication

Why *dynamic*?

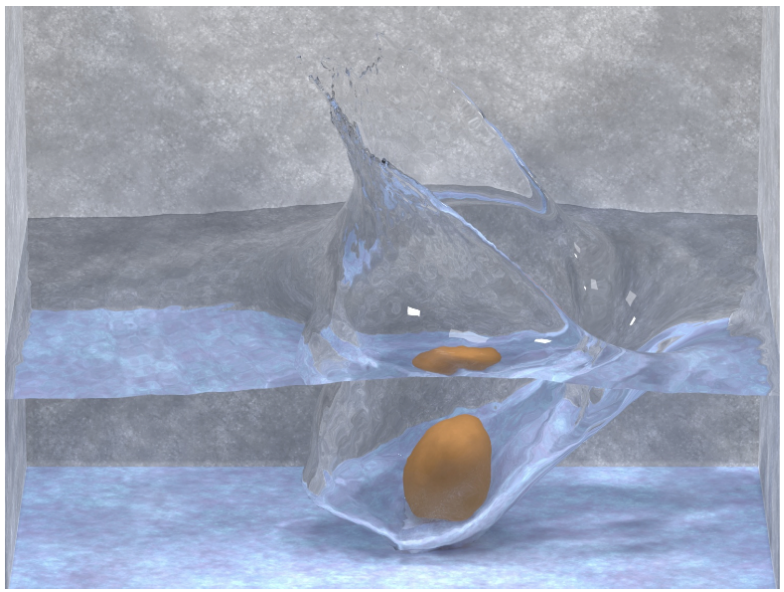
For instance:

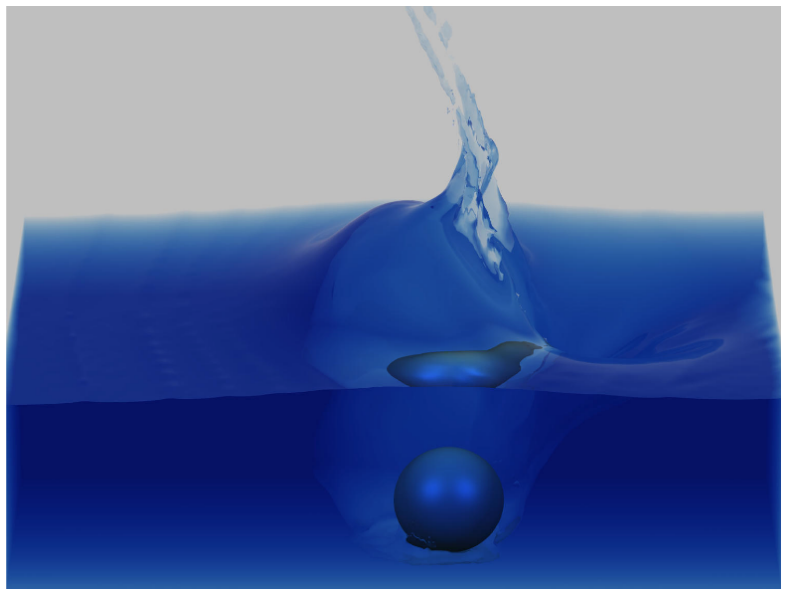
- angiography
- veterinary
- monitoring reaction to cancer medication
- nondestructive testing

Example: (2+1)-dim. angiography

Important cardiology test and procedure.

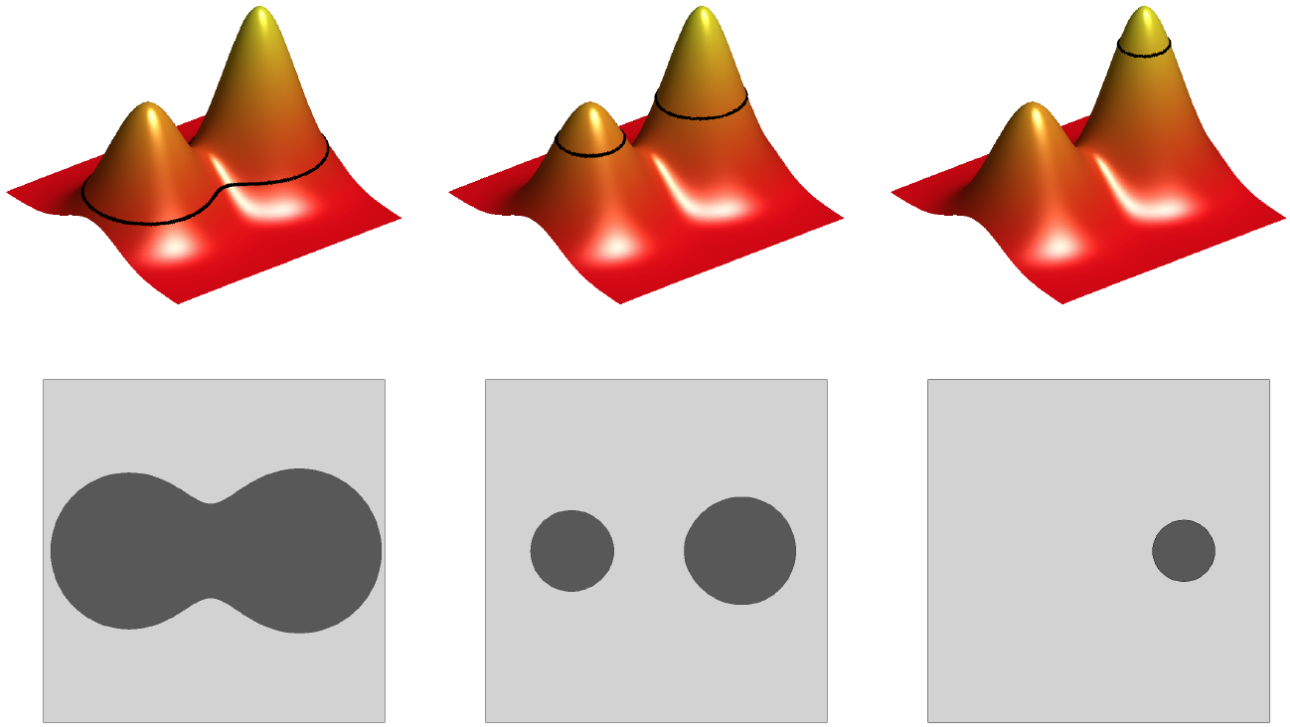
Level Set Method





Photorealistic water effects. Largely used in animation movies.

Level Set Method



Γ: plane dynamic curve.

$\phi = \phi(x, y)$: level set function.

$\Gamma = \{(x, y) : \phi(x, y) = 0\}$ (zero level set of ϕ).

ϕ can be any function that models the contour.

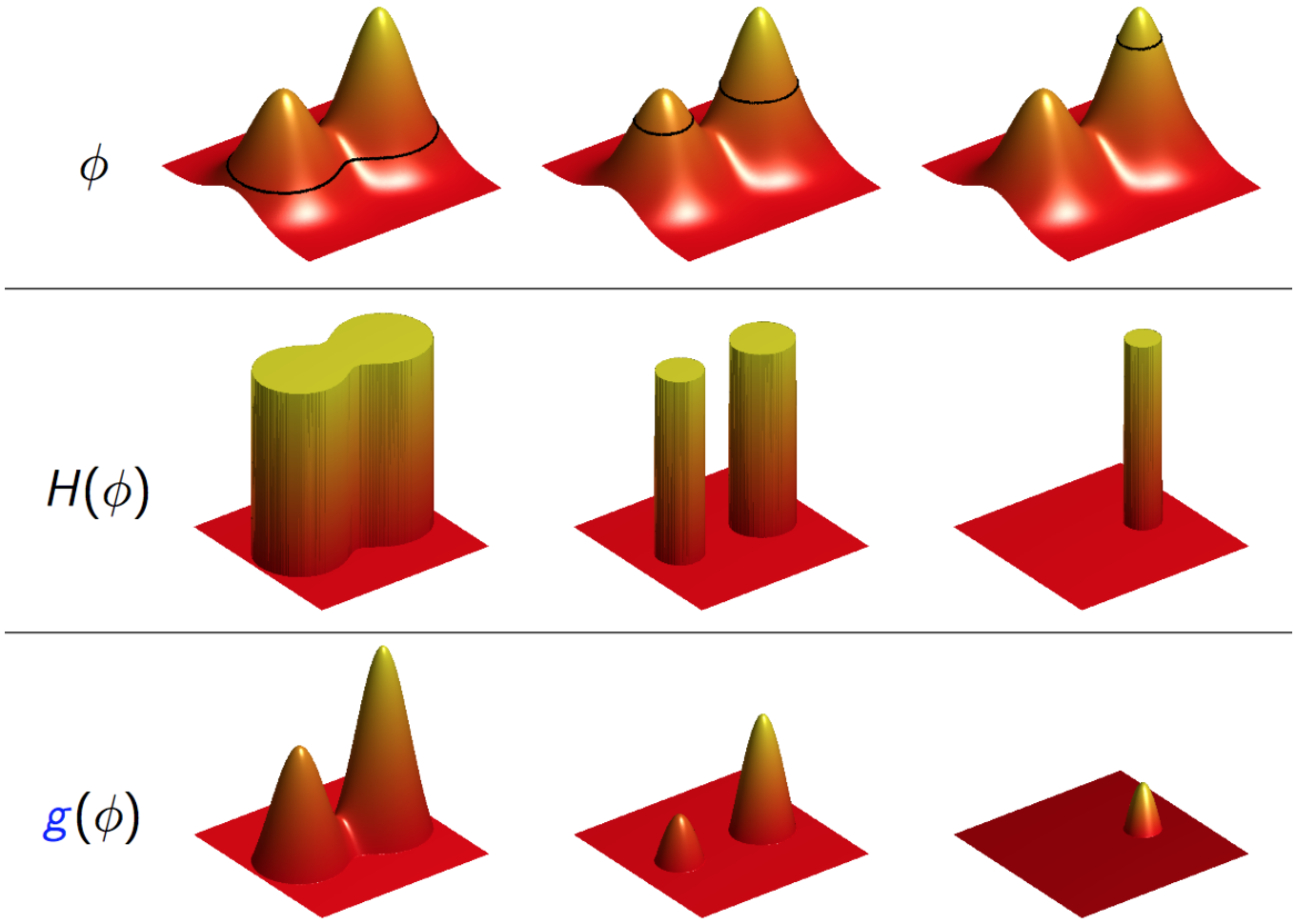
The new model

The X-ray attenuation is approximated by $g(\Phi)$.
Our **cost functional** is:

$$F(u) = \frac{1}{2}\|A(g(u)) - m\|_{L^2}^2 + \frac{\beta}{2}\|\nabla u\|_{L^2}^2$$

g is a *cutoff* function we wisely choose.
By "weird differentiation" of $F(u)$ we get to a PDE (*evolution equation*): the algorithmic time of its solution is Φ.

Level Set Method



The story, so far

2008: Kolehmainen, Lassas, & Siltanen: level set method for 2D case ("normal" CT data).

2013: Niemi, Lassas, & Siltanen: level set method for (2+1)D case.

Hopefully soon: Elefante & friends: level set method for (3+1)D case.

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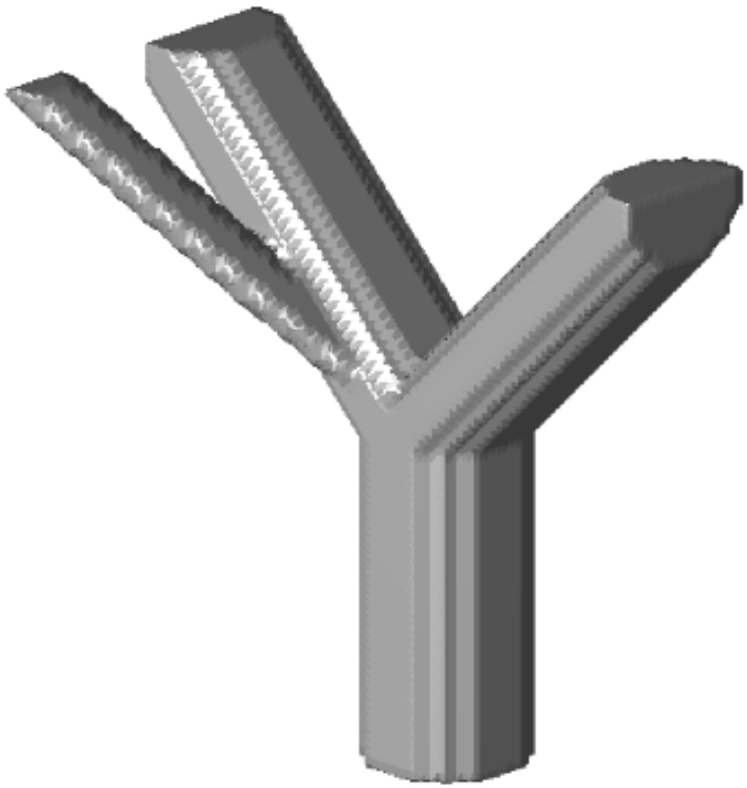
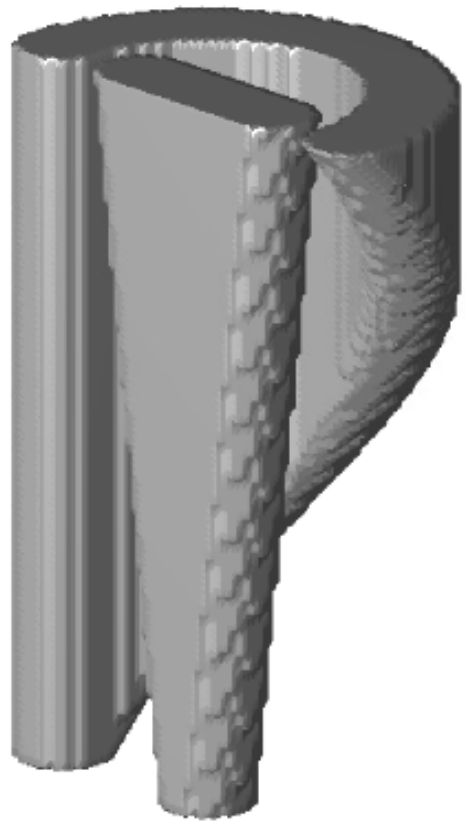
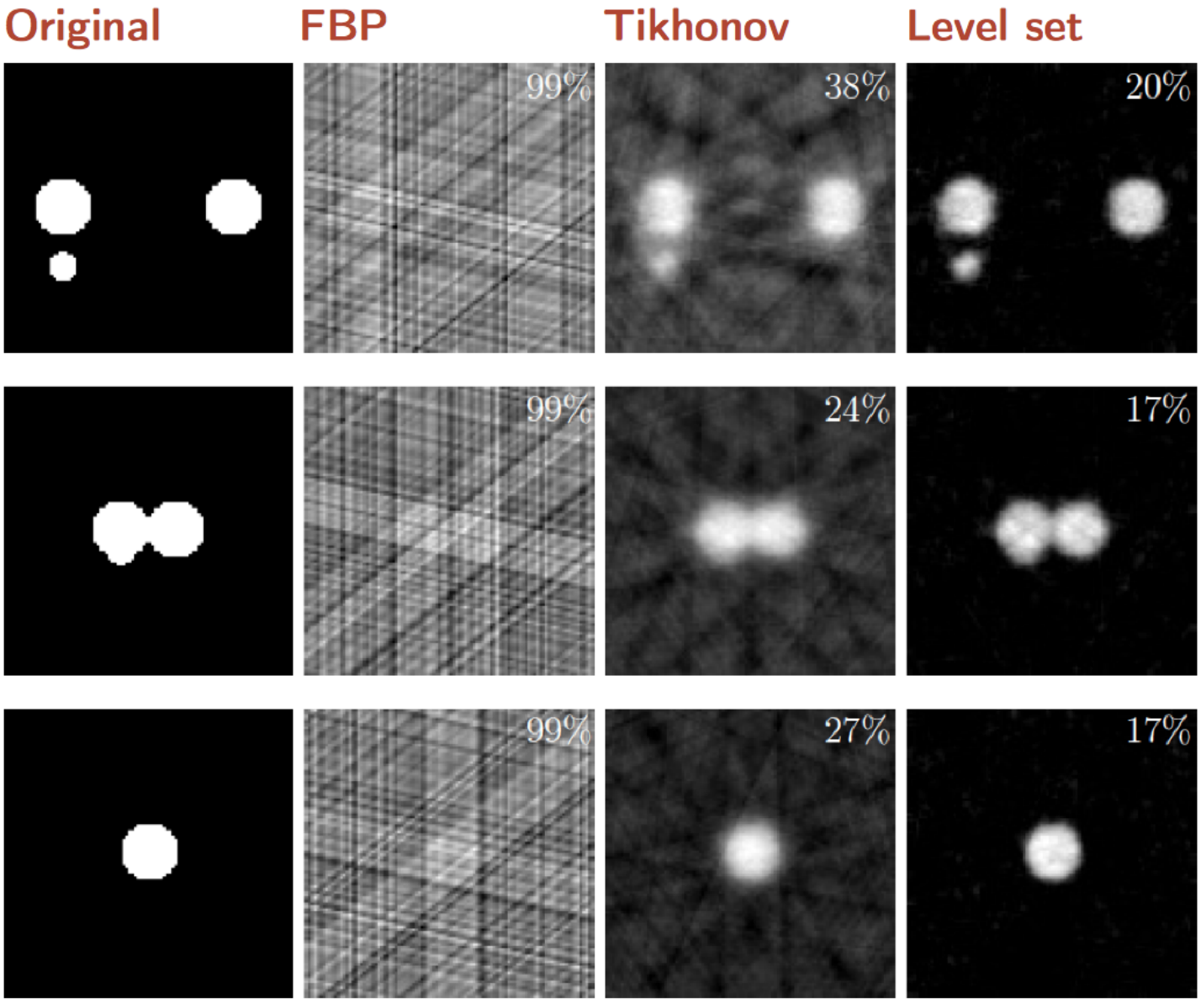
A comparison of methods

Let's take a couple of phantoms.





A comparison of methods



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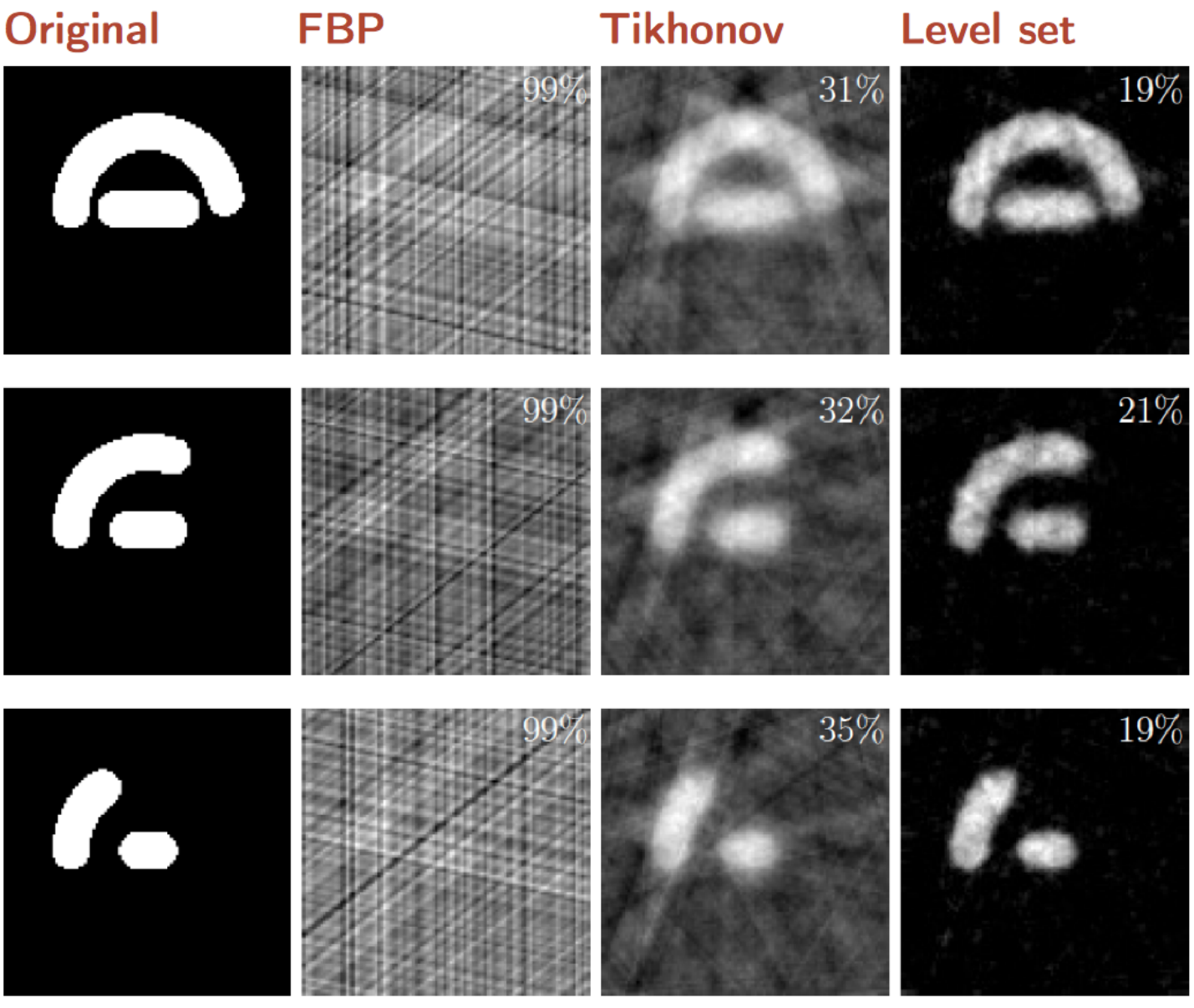
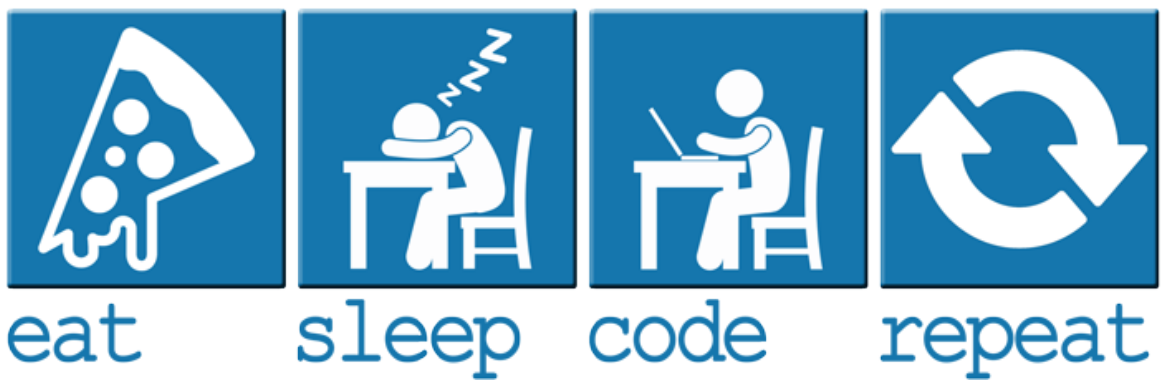


Upcoming challenges

- Testing different cut-off functions.
- Generalizing to (3+1)D case.
- Generating smart simulated data.
- Testing on real data.
- Proving all the provable: conditions for the existence of a solution of the evolution equation, convergence proofs, etc.



Thank you for your attention.

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May 18th-22th, 2015