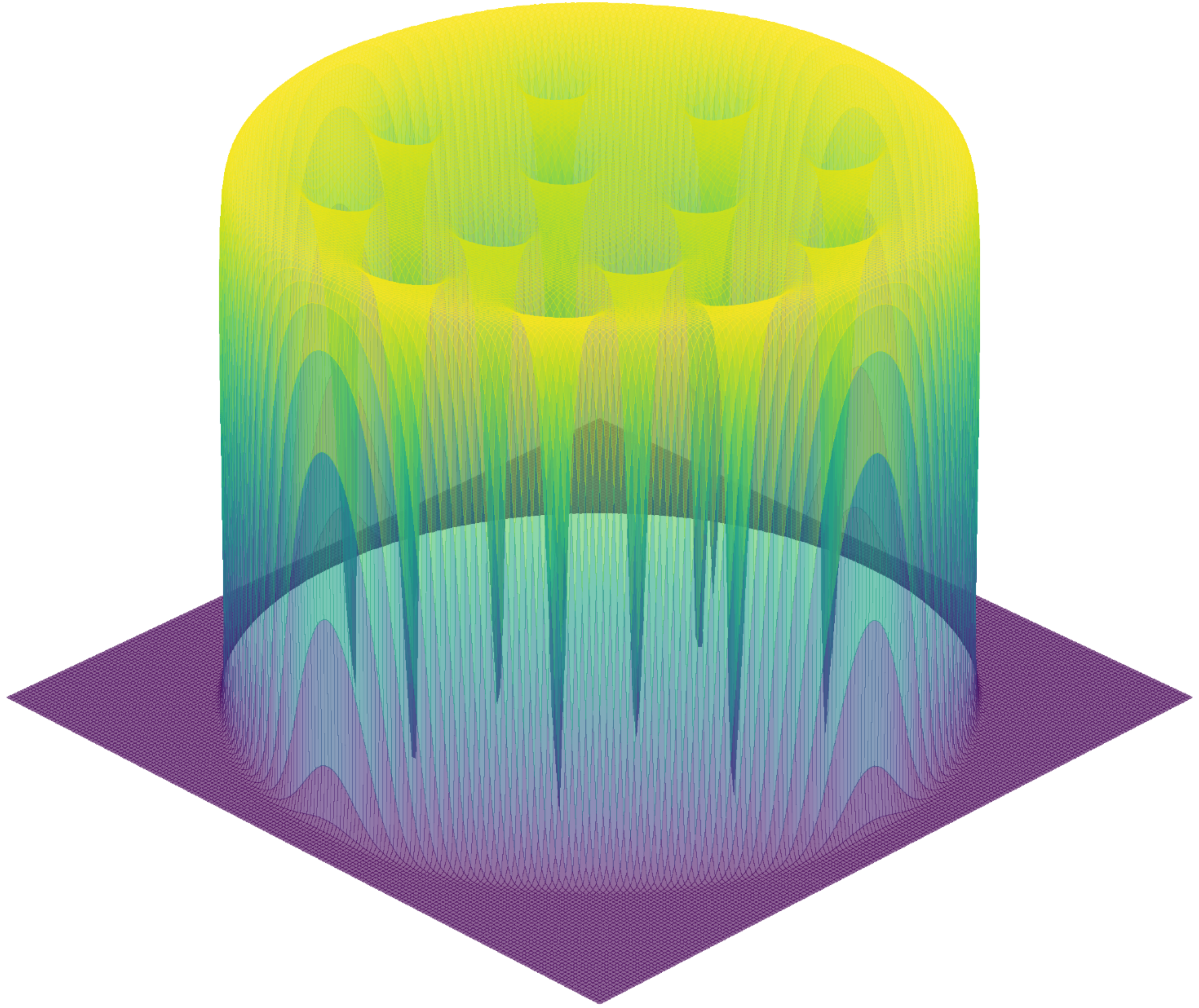
Exotic superfluids of homogeneous Bose-Einstein condensates



Matthew Edmonds &
Matthew Davis
University of Queensland

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13th December 2022

In this talk…

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- unique vortex patterns found with unusual symmetries

Inhomogeneous trapped gases

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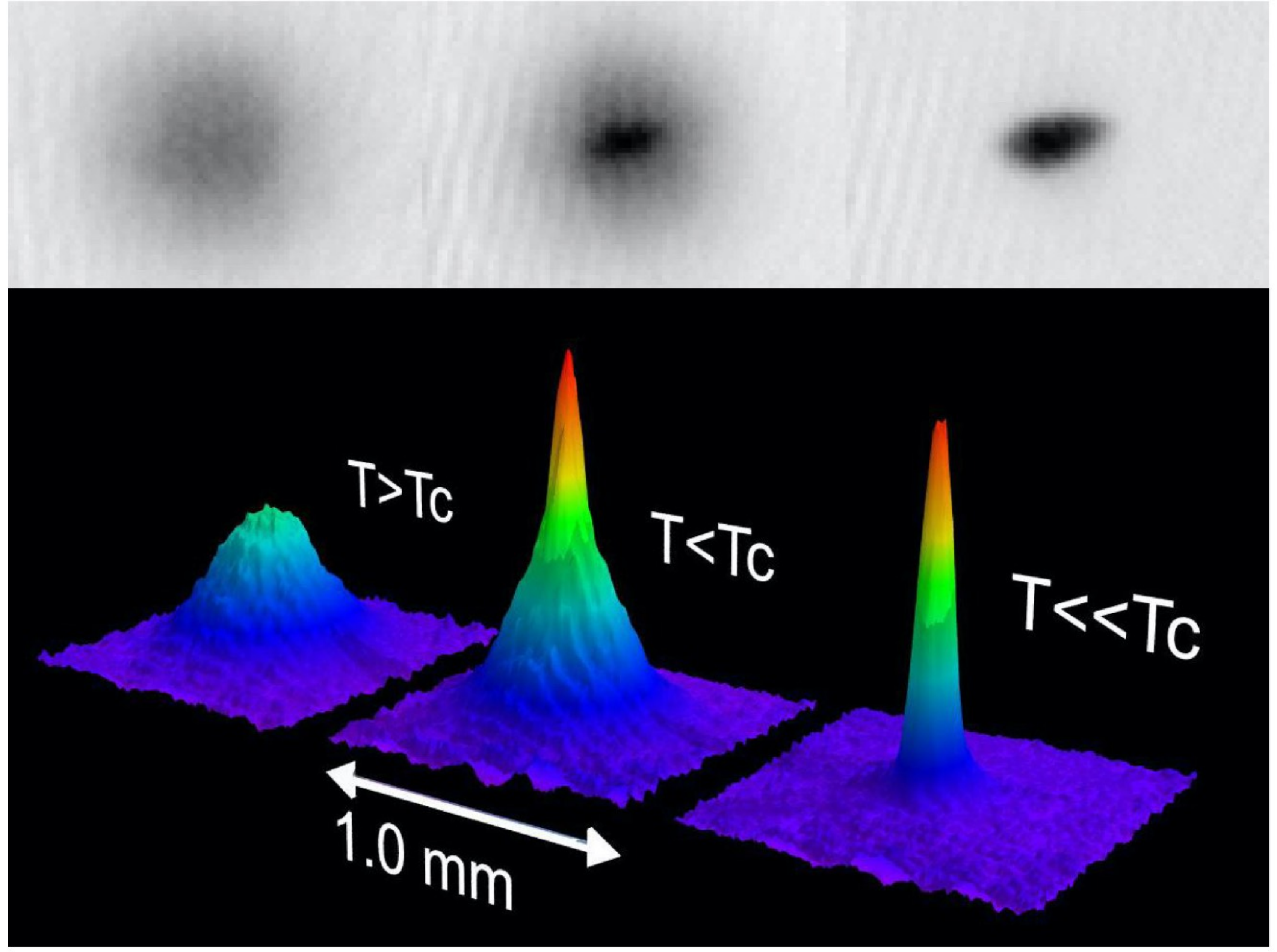

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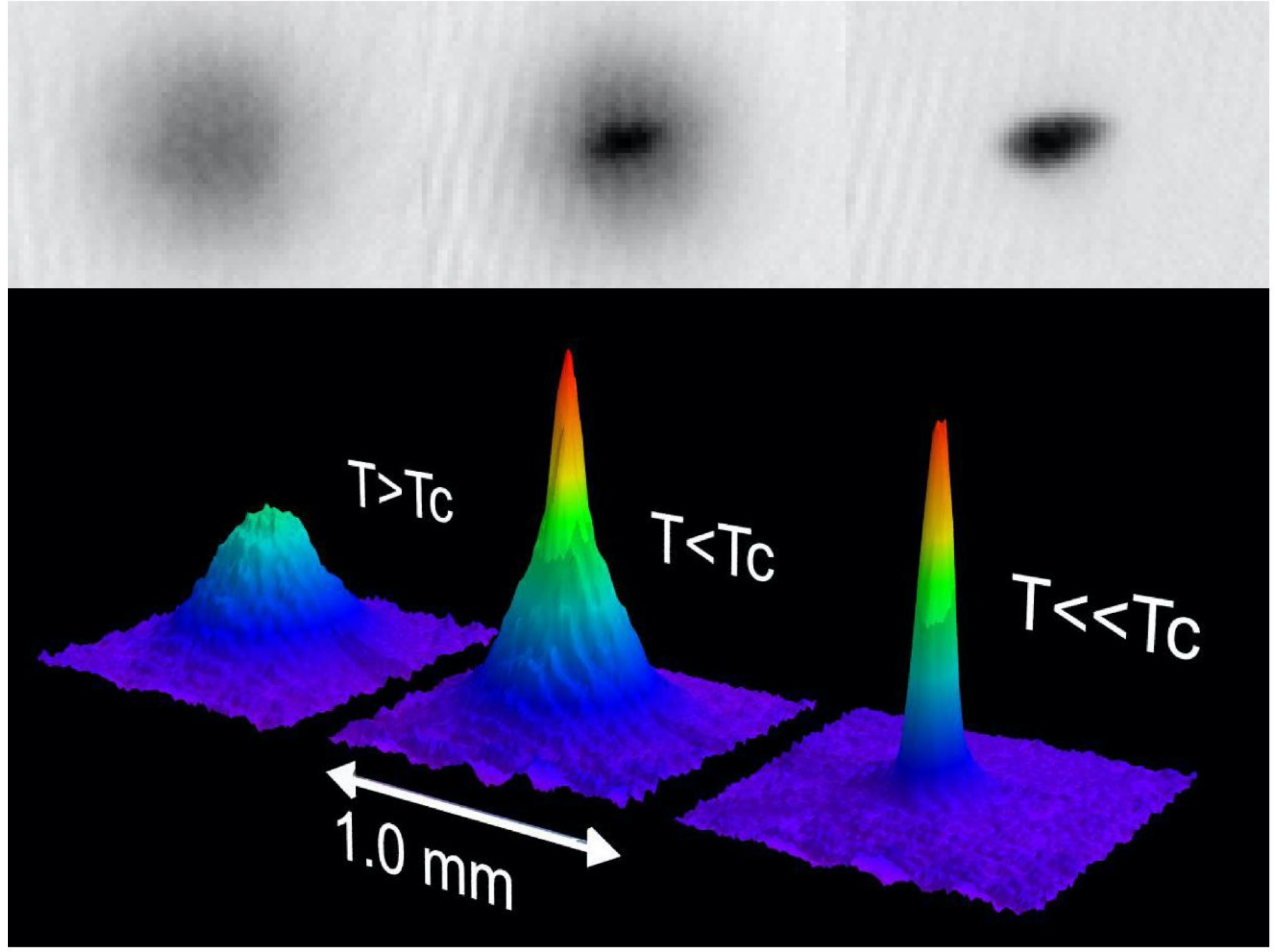

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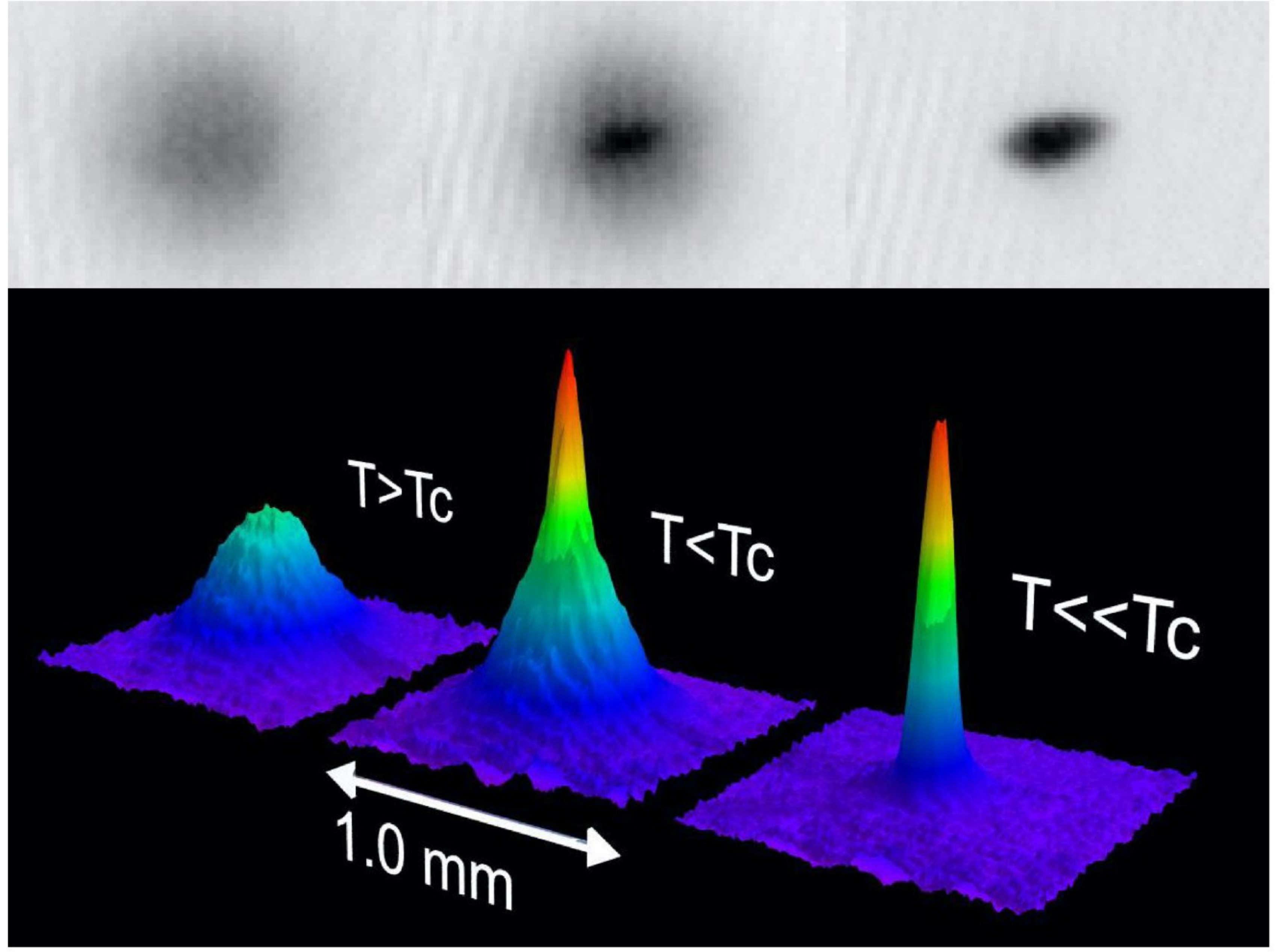

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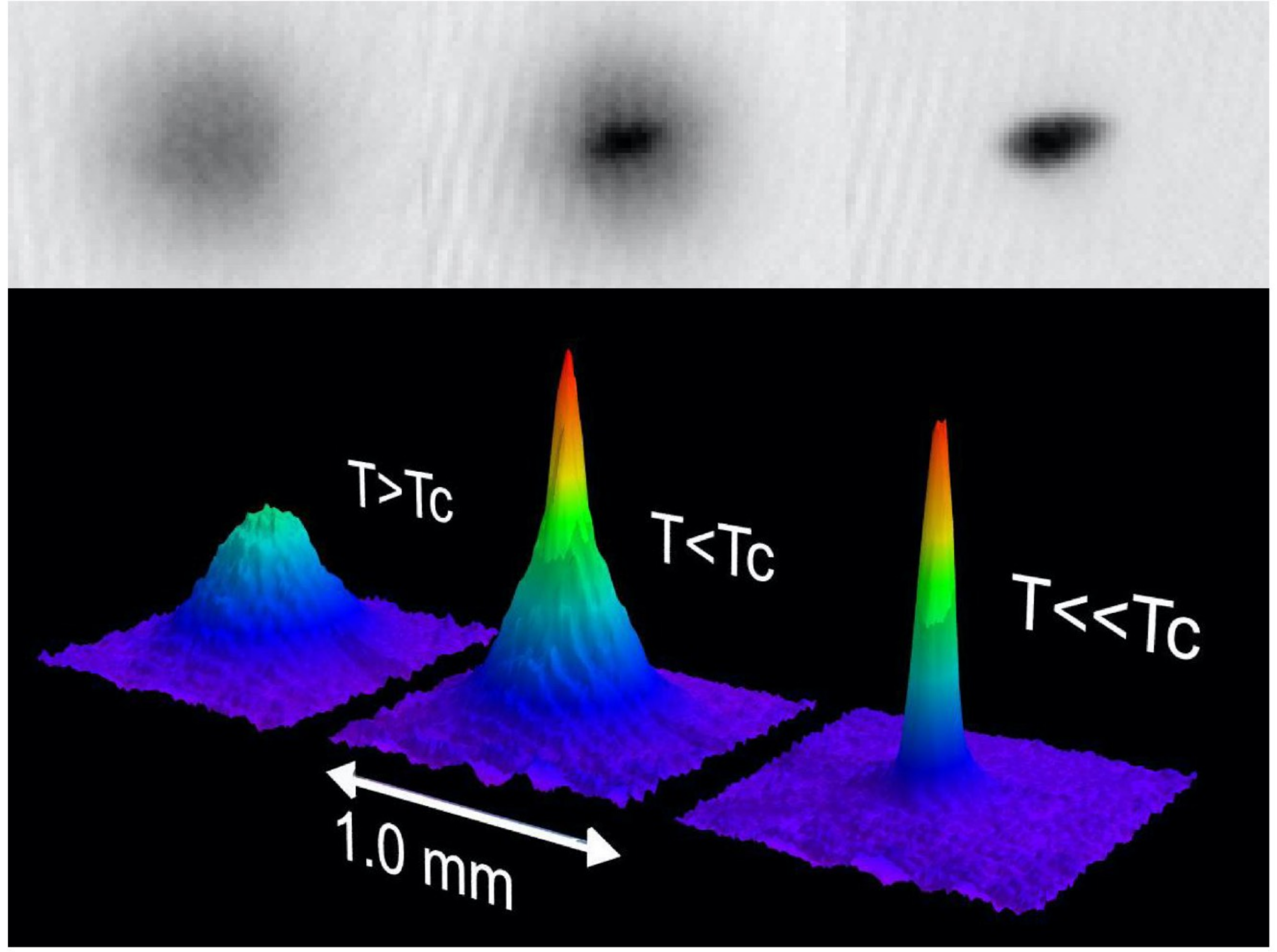

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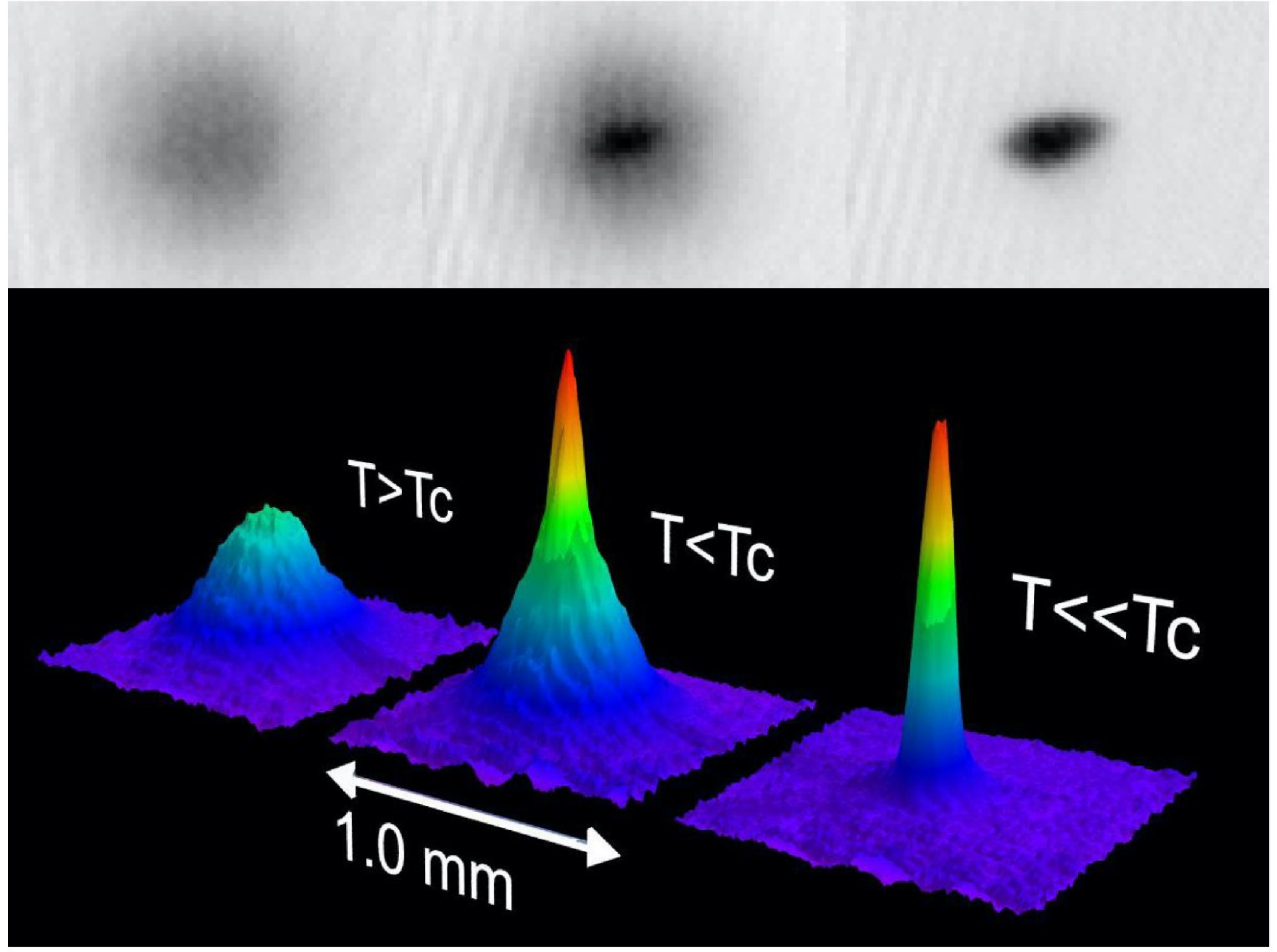

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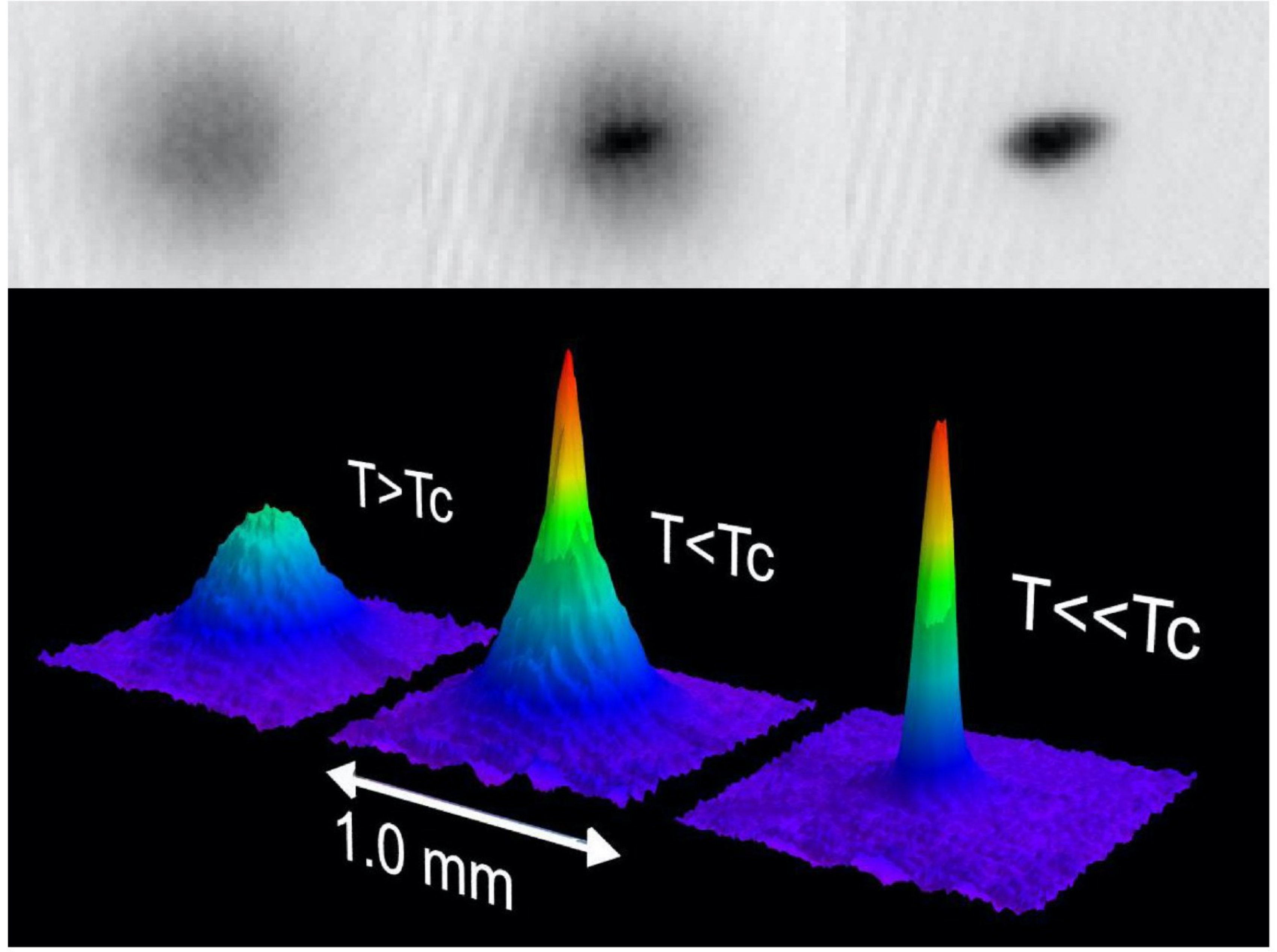

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Experimental techniques

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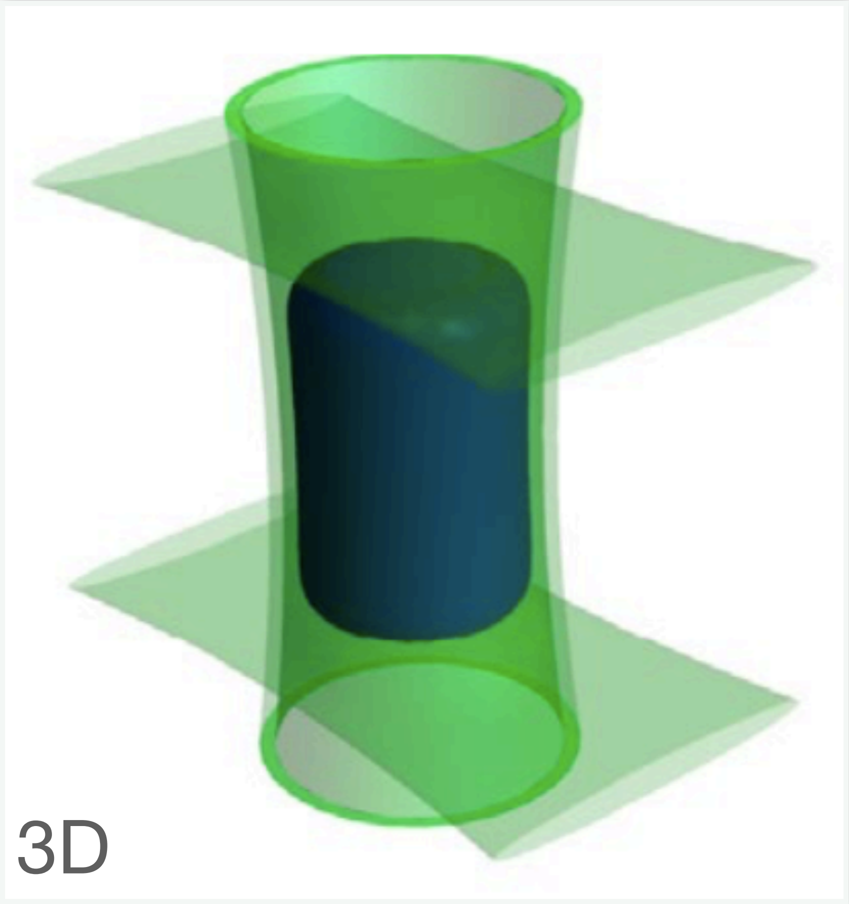

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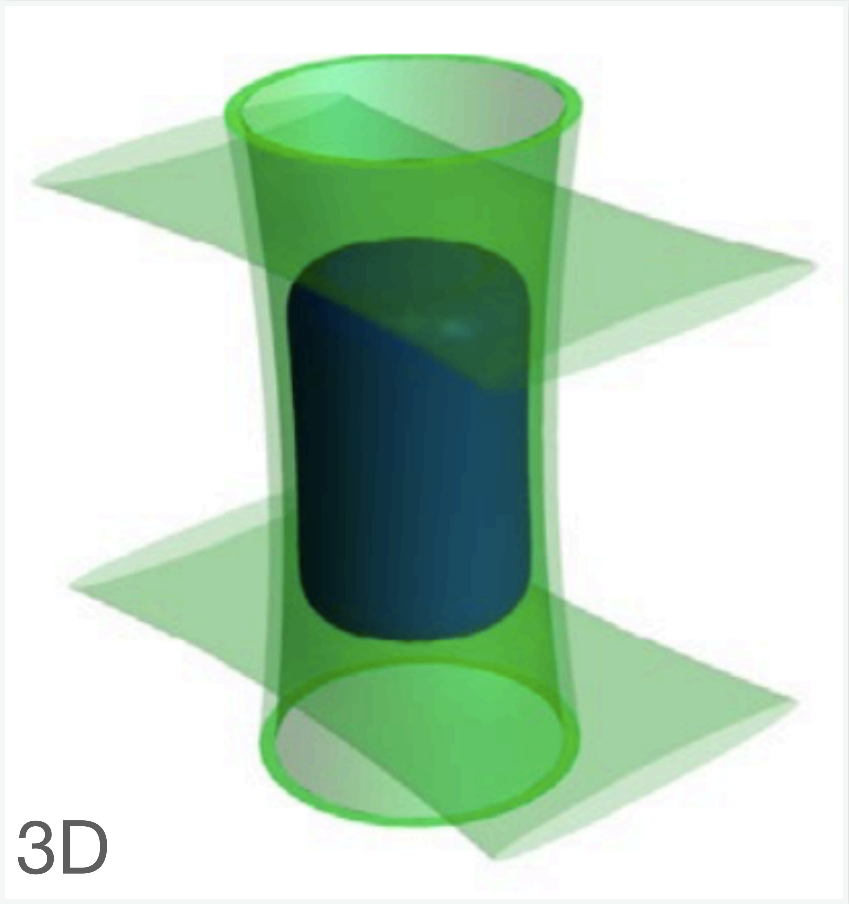

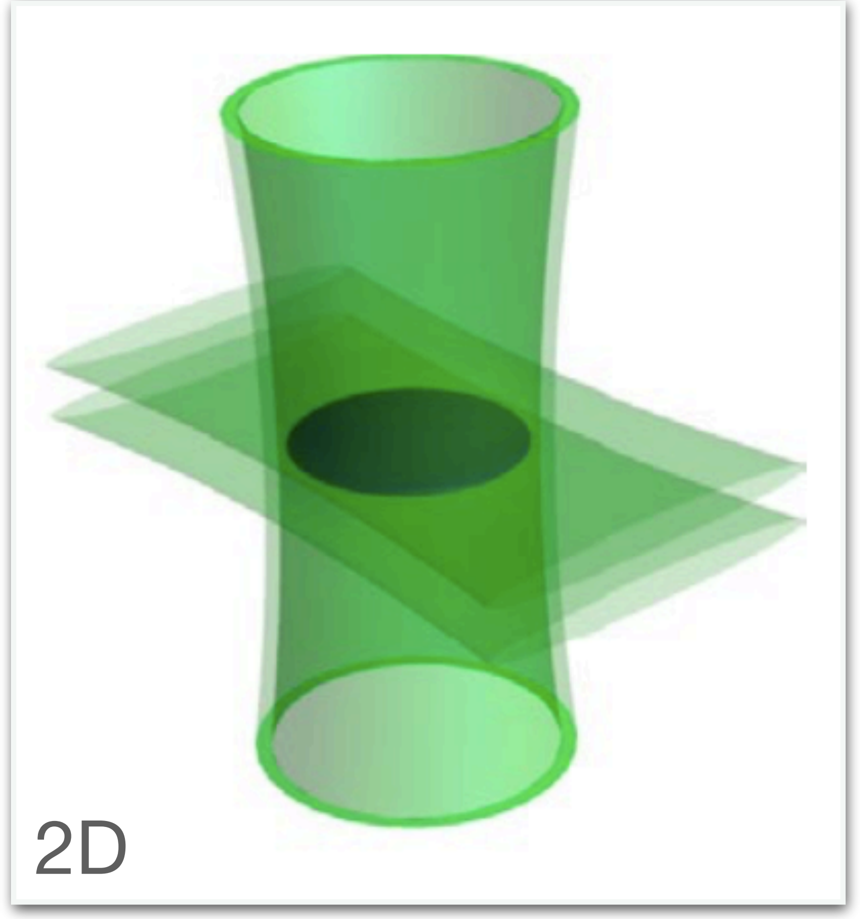

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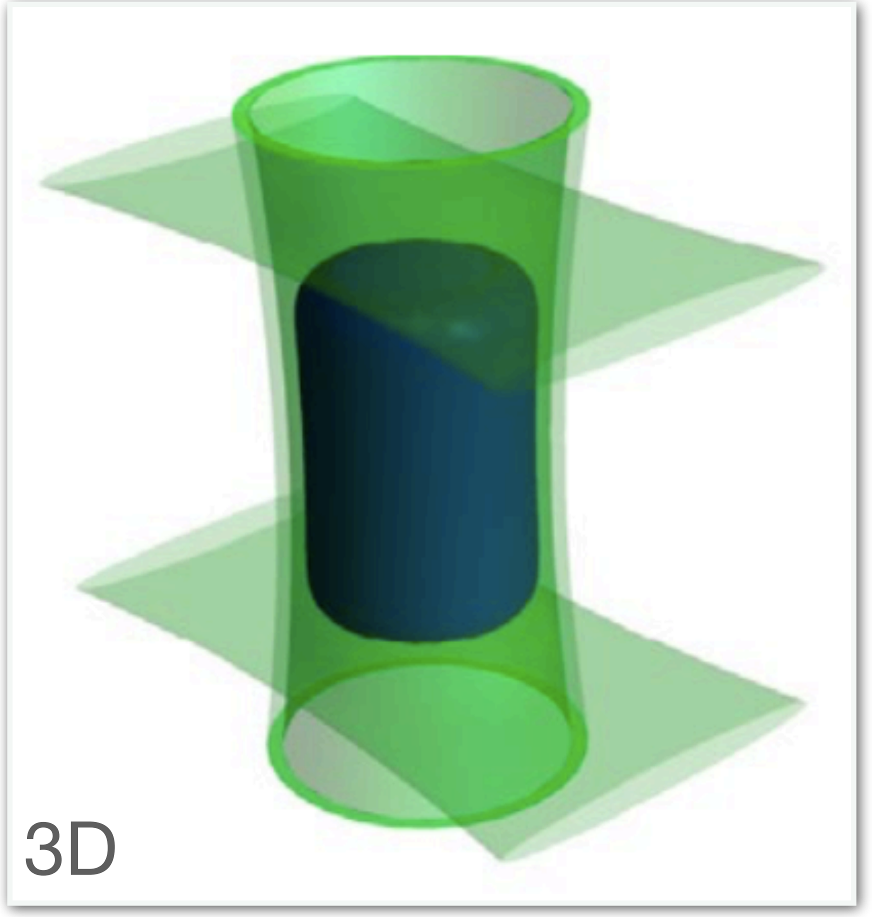

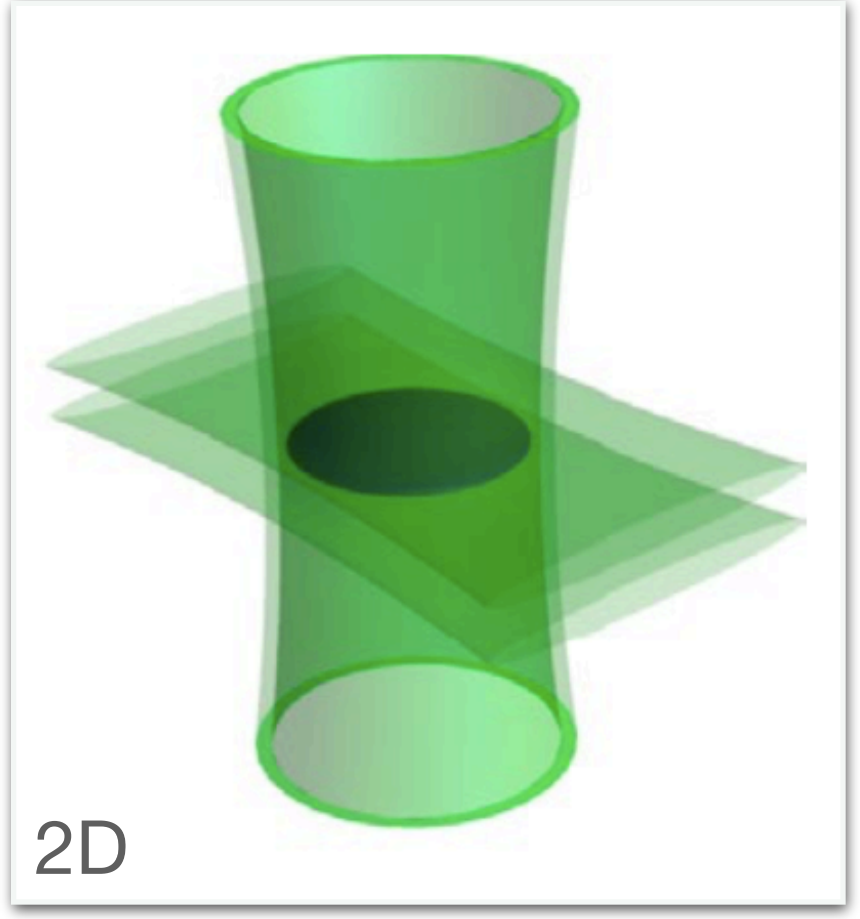

repulsive lasers create walls of potential

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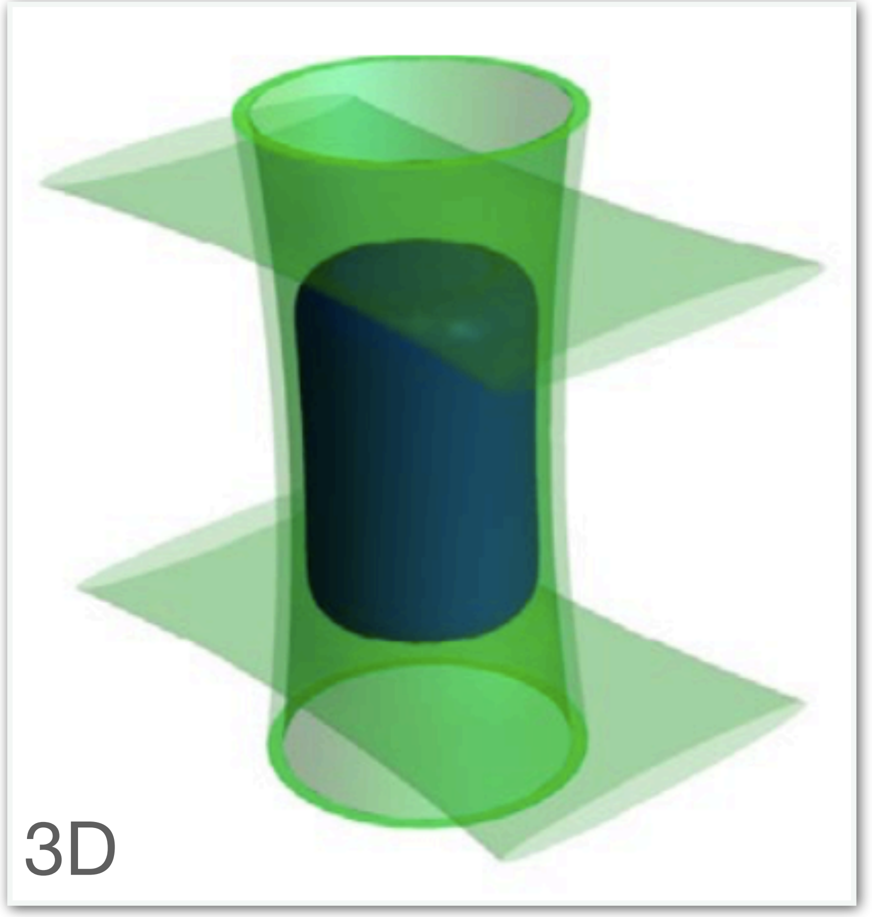

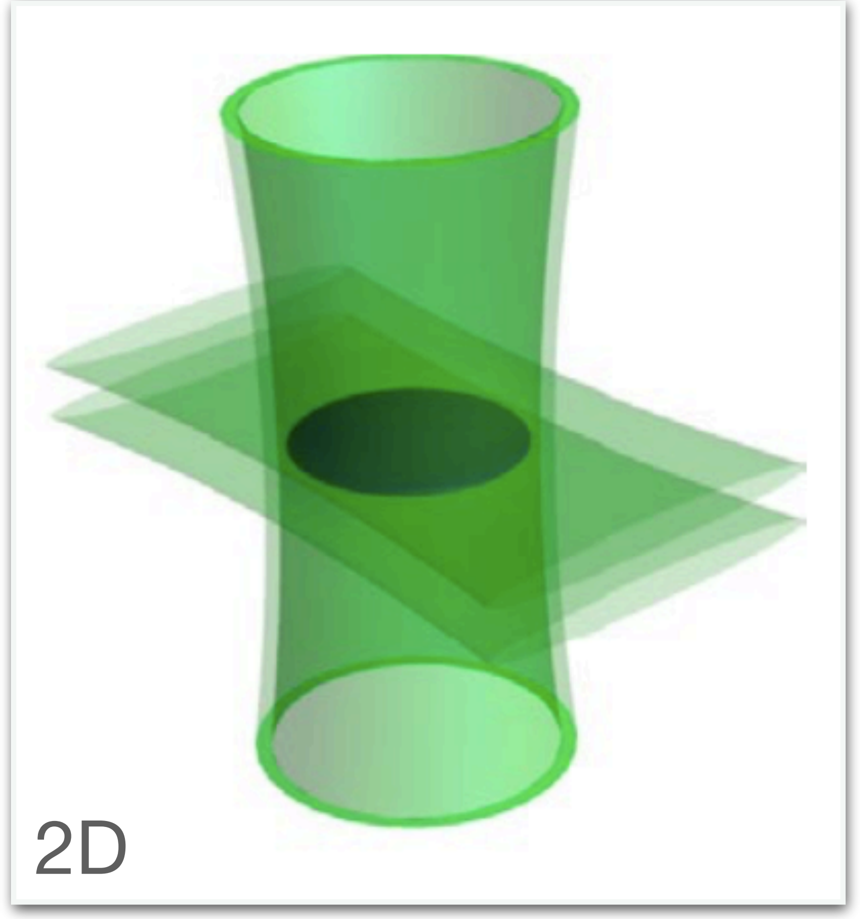

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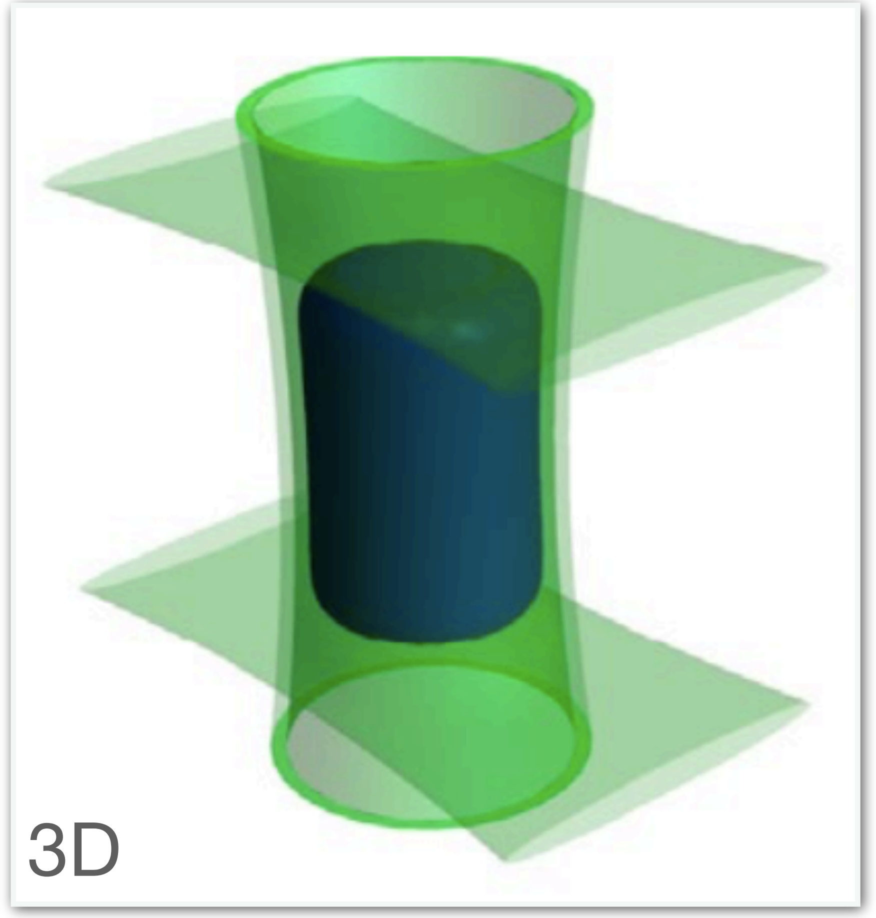

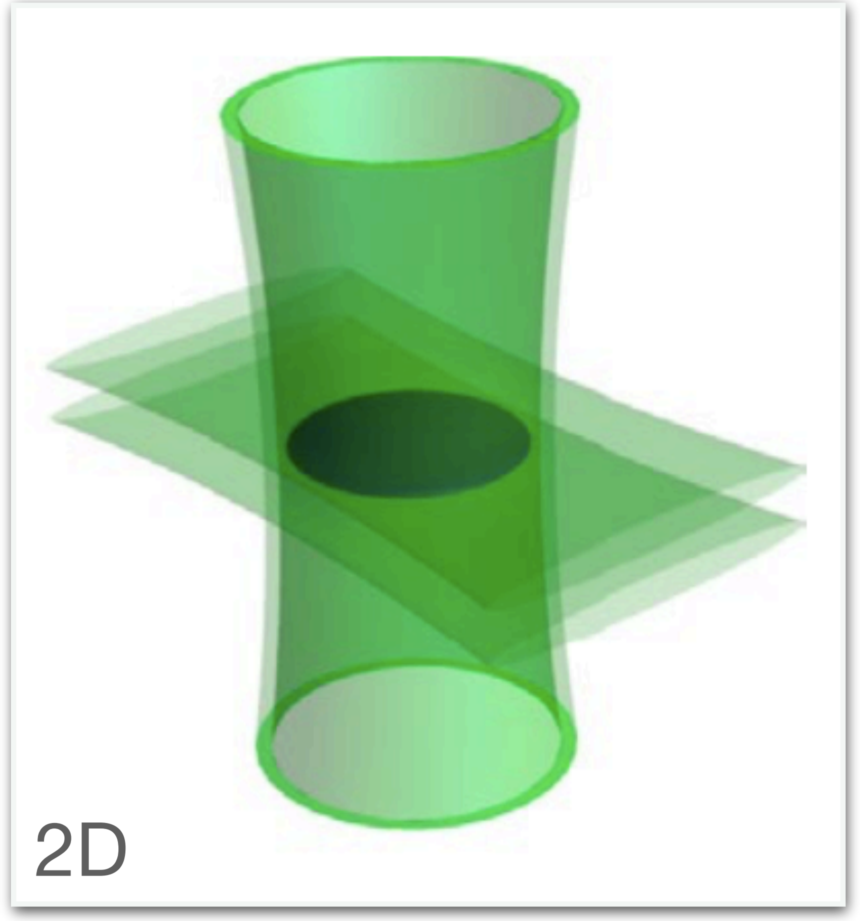

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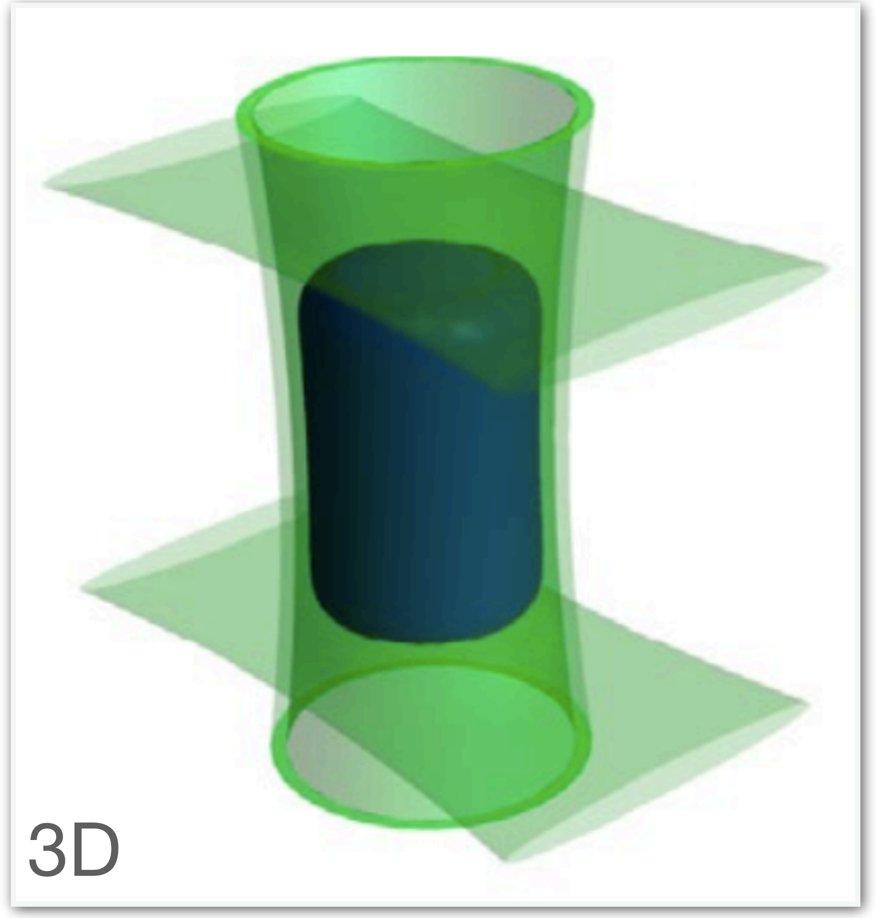

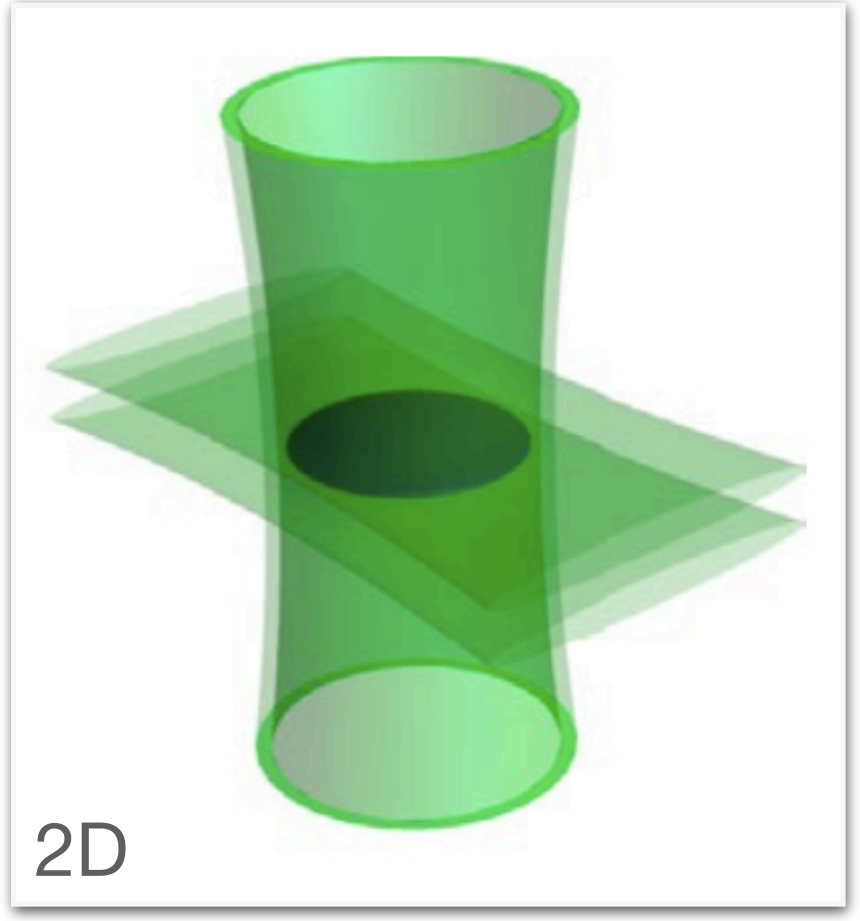

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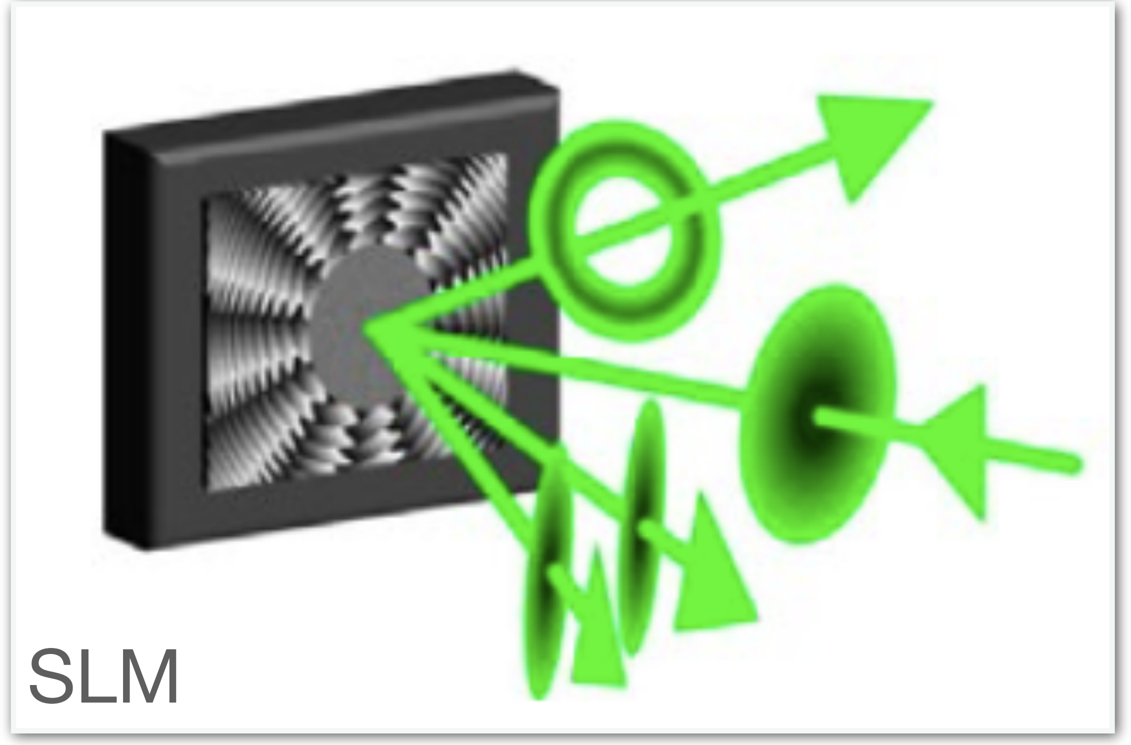

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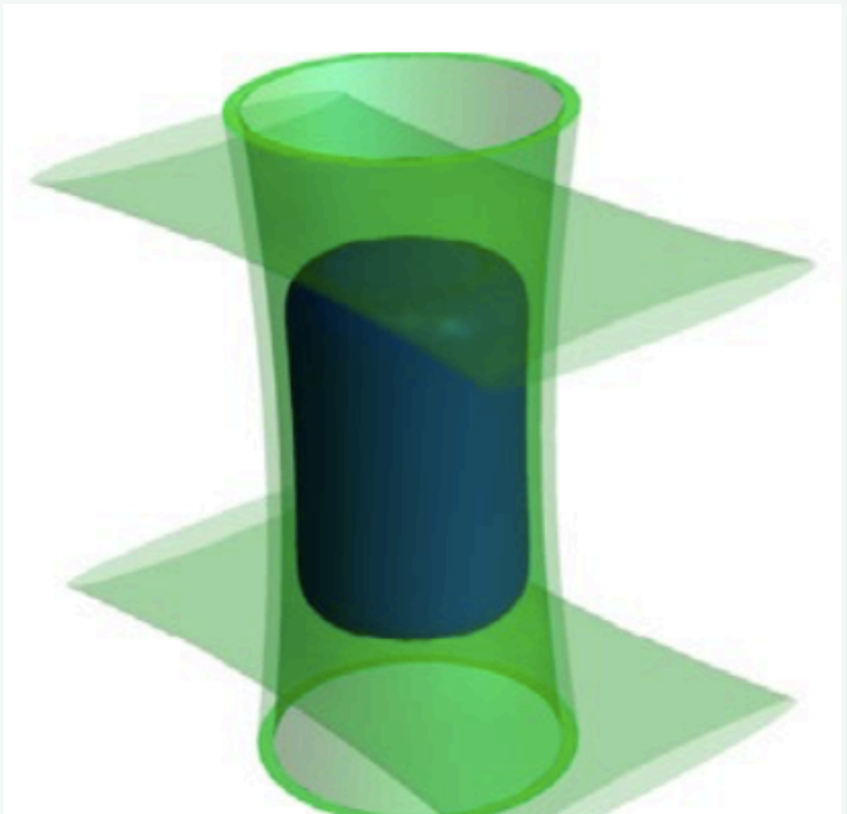
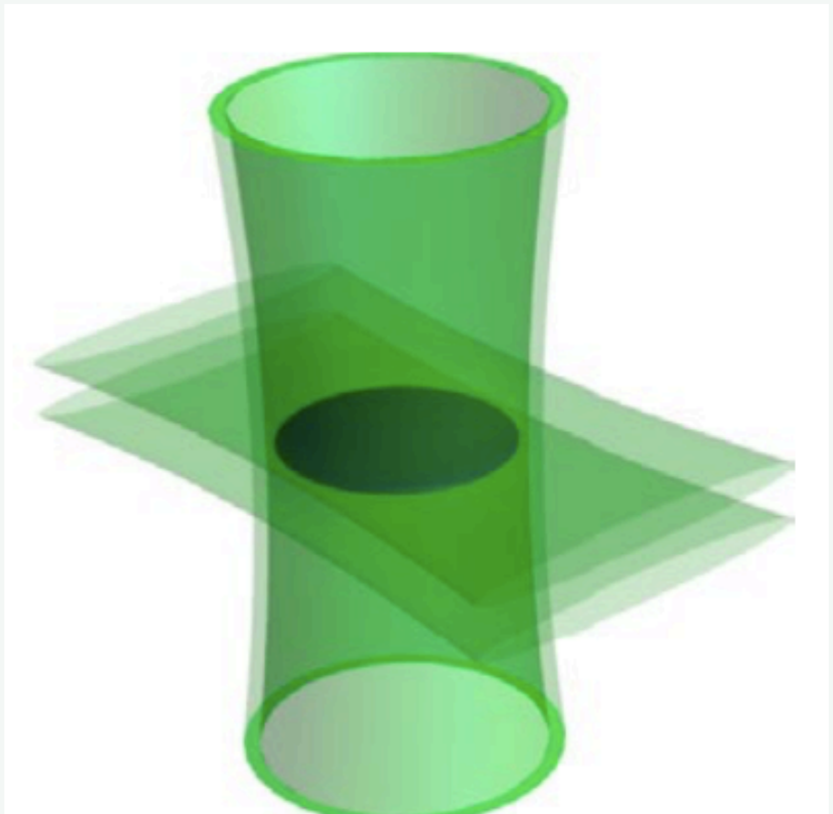


3D



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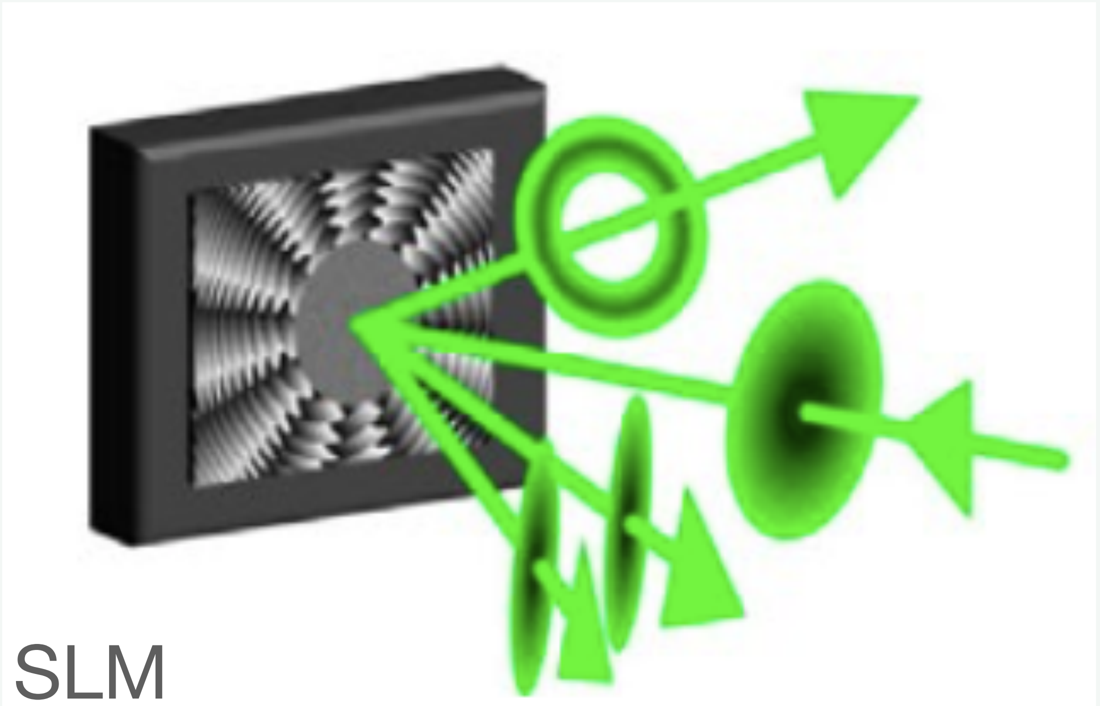

SLM

DMD

N. Navon, R. P. Smith, and Z. Hadzibabic, Nat. Phys. **17**, 1334 (2021)

Homogeneous box potentials

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U_\Sigma(x,y) = {} & U_\perp(x,y) + U_\perp(y,x) + \theta(r_\pm) r_\pm \left[1-\theta(x_+)\right]\theta(y_-) \\
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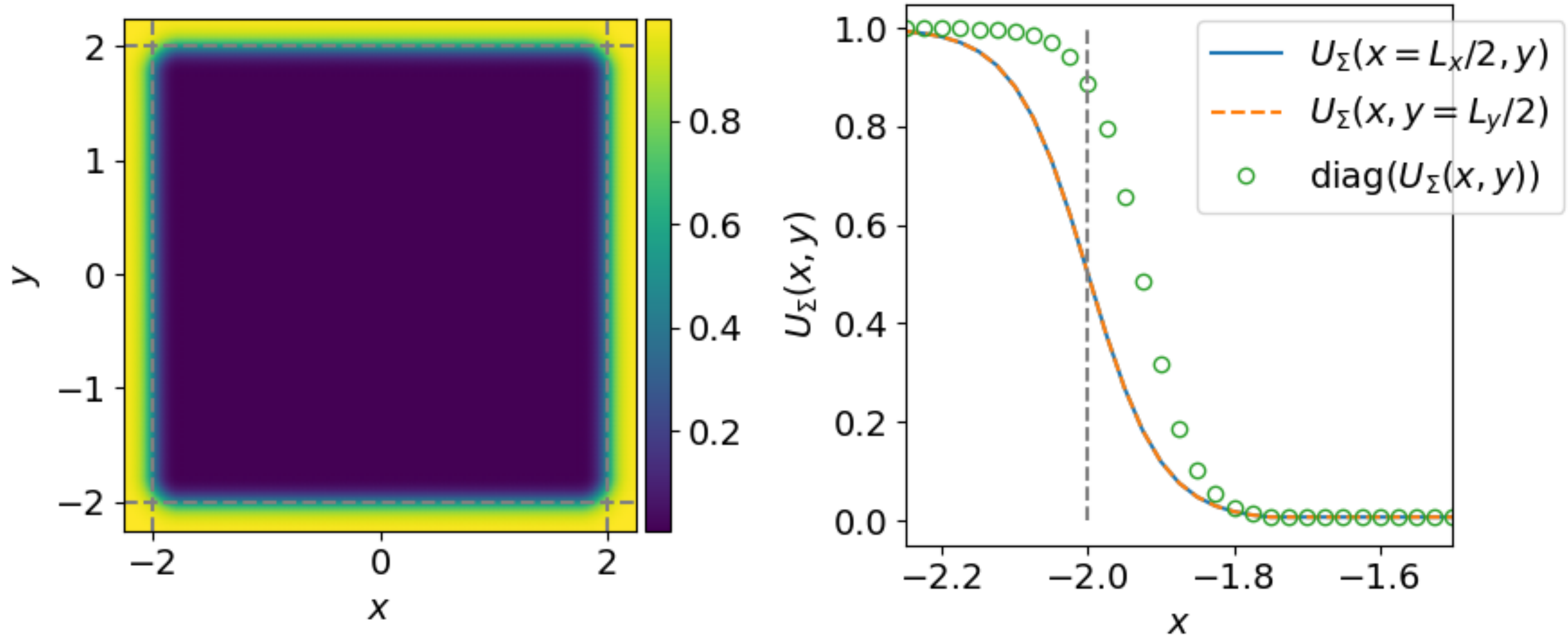

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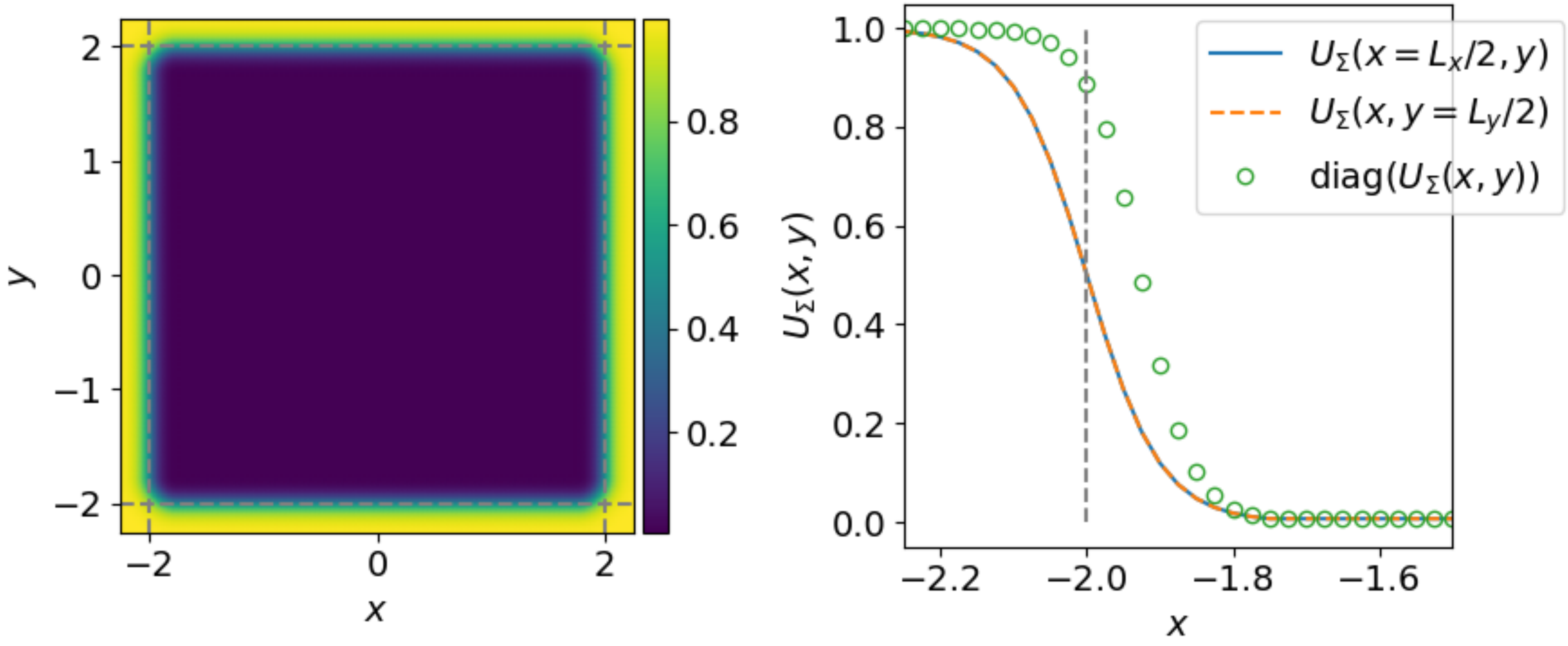

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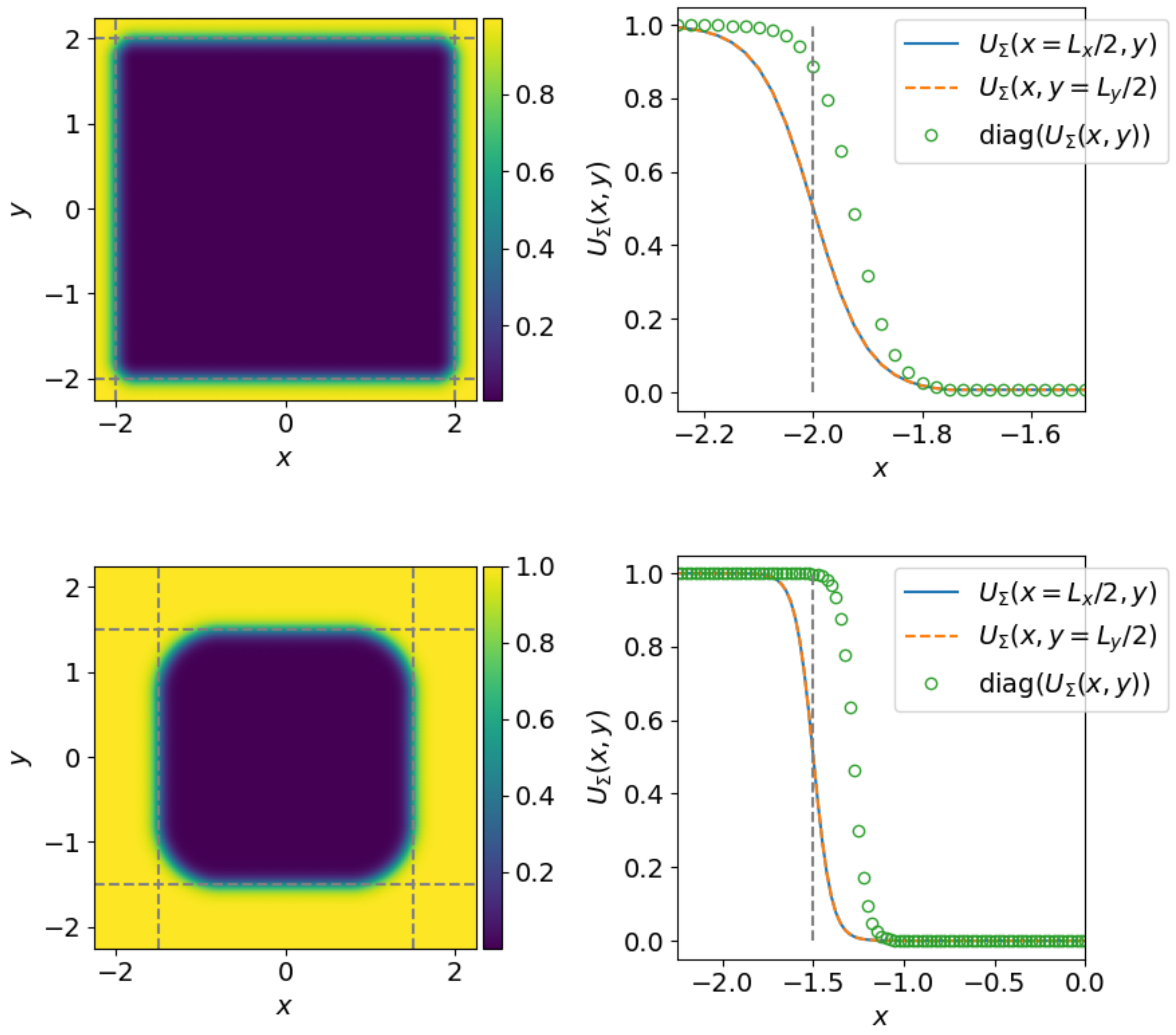

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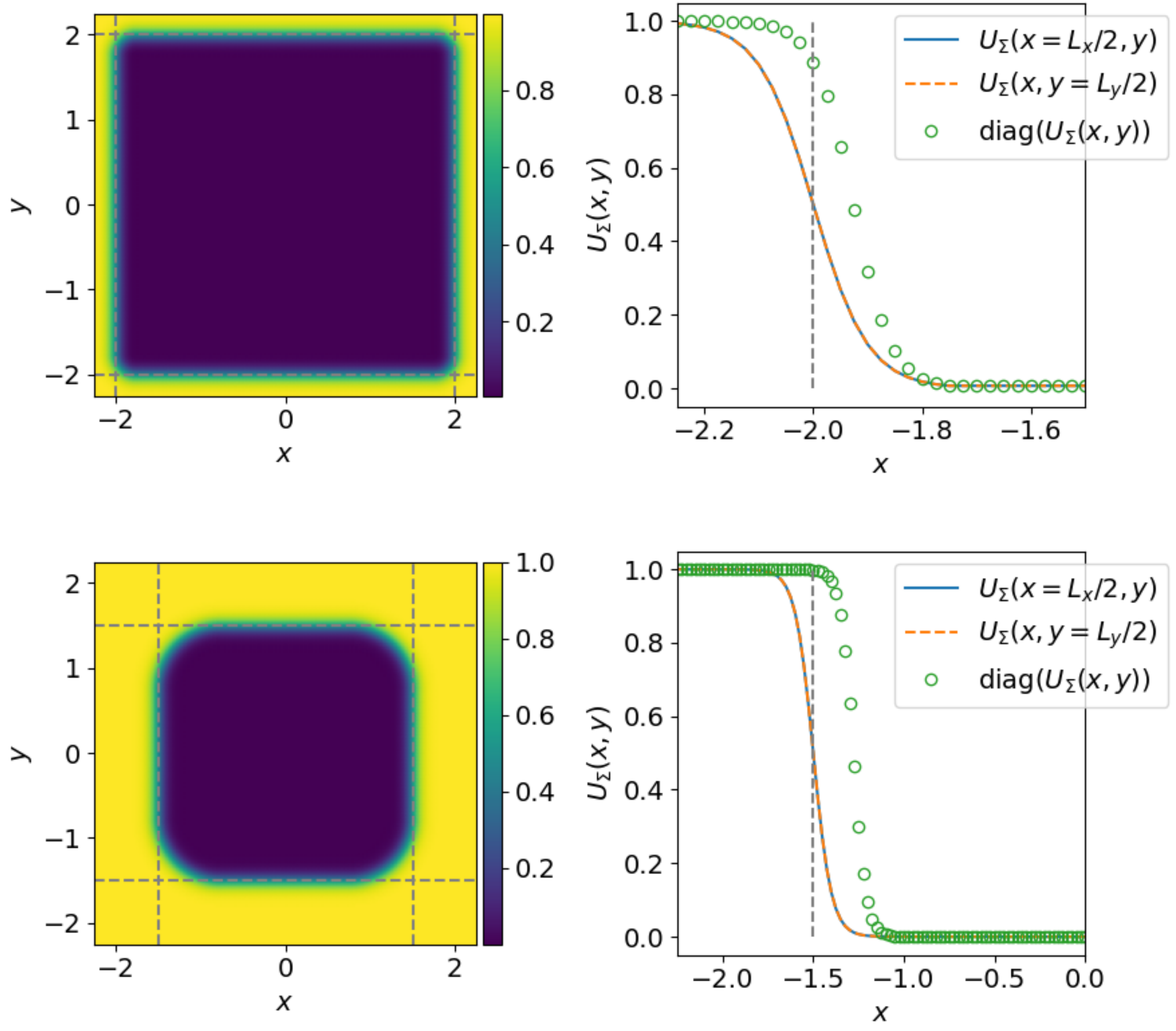

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$\xi = \hbar/\sqrt{mn_{2d}g_{2d}}$ **(healing length)** $\{x,y\}\rightarrow\{x,y\}/\xi$, $\psi\rightarrow\sqrt{n_{2d}}\,\psi$, $E_{\text{2D}}\rightarrow E_{\text{2D}}/(n_{\text{2D}}g_{\text{2D}})$ **(energy)**

Numerical results

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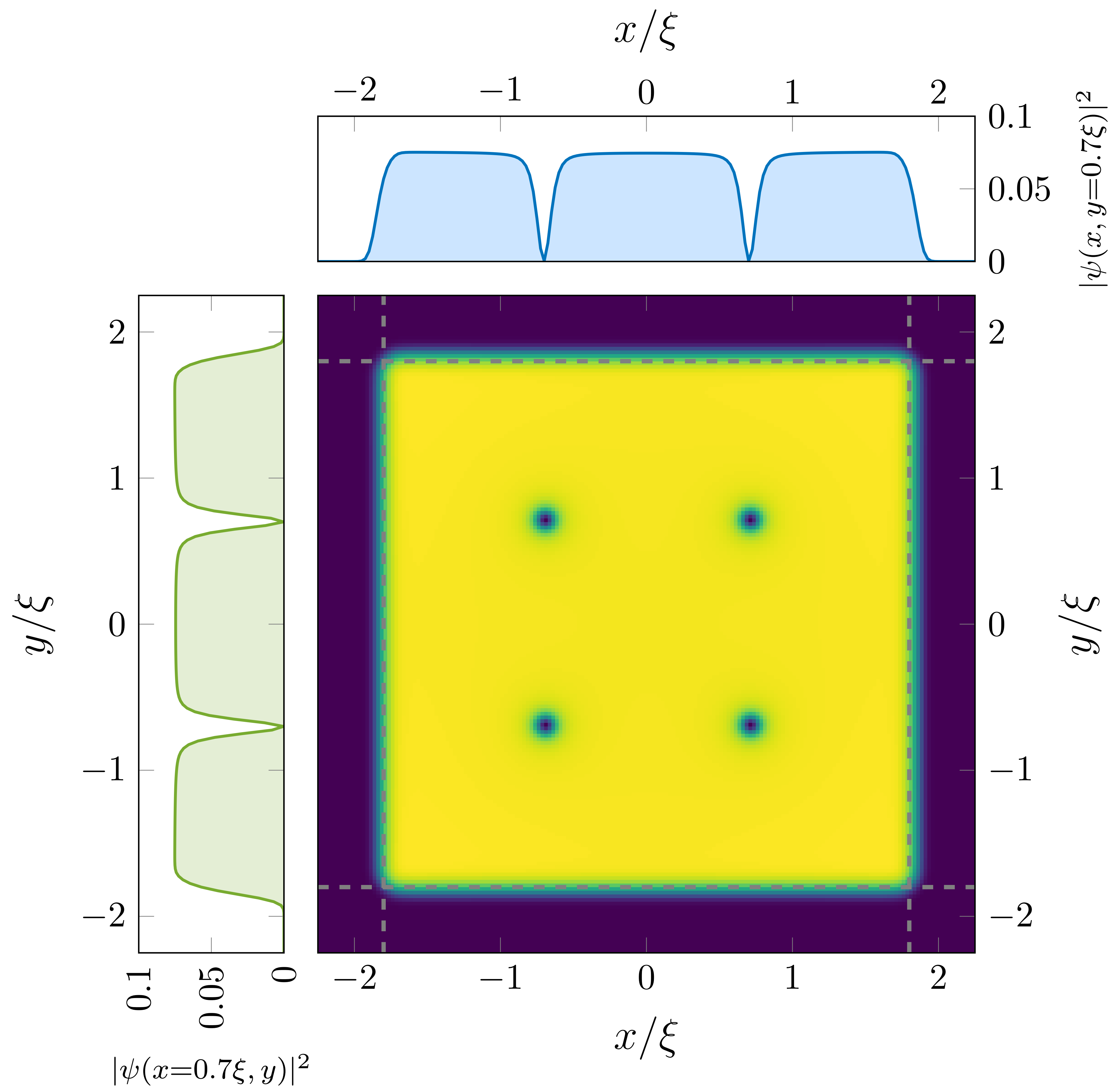


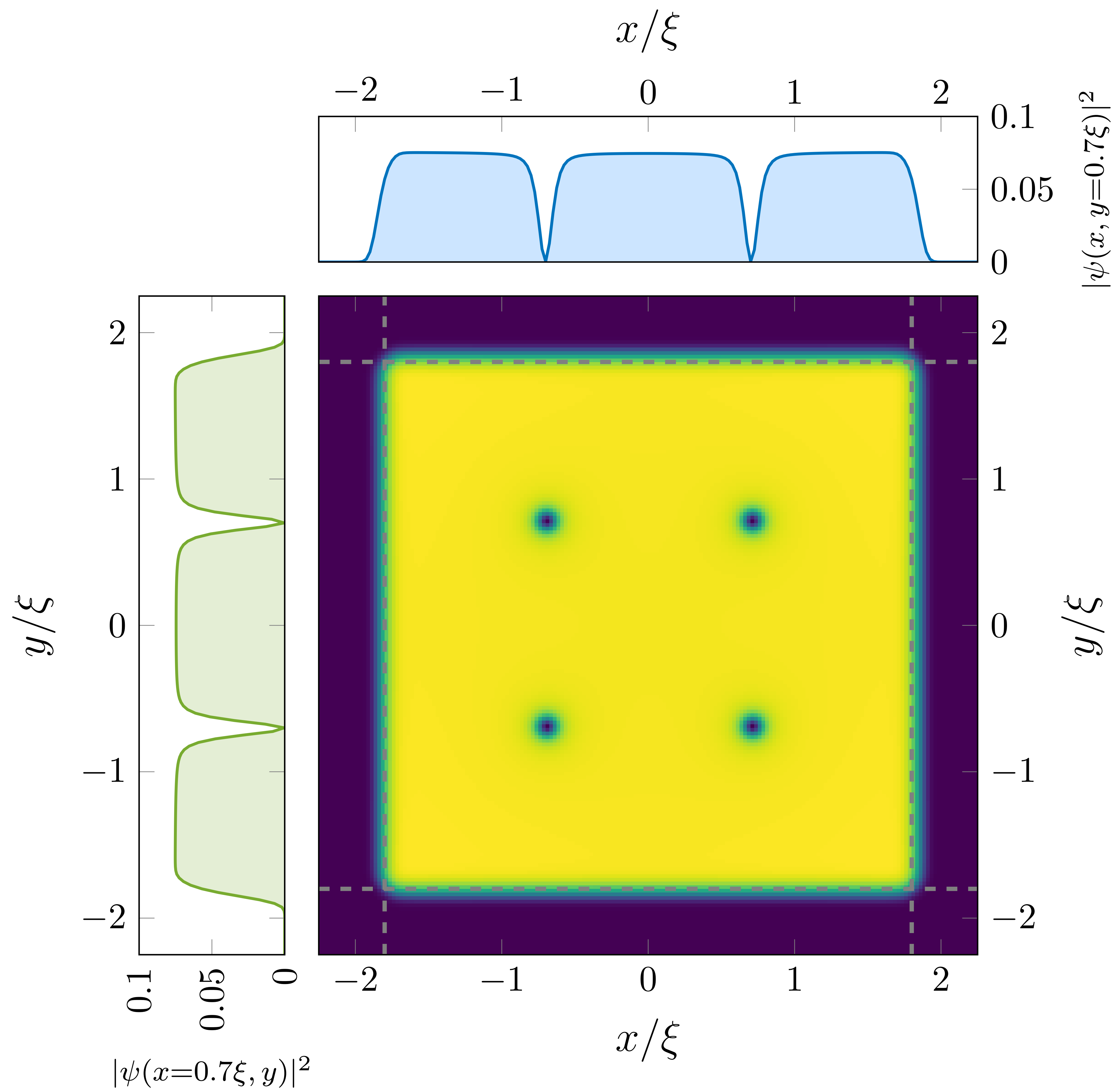
Numerical results

$$\Omega = 1.6\frac{\hbar}{n_{2d}g_{2d}},$$

$$g = 5\times 10^3 g_{2d},$$

$$w = 4dx/\xi,$$

$[L_{x,y}/\xi{=}2.25/\xi,\ L{=}1.8\xi]$



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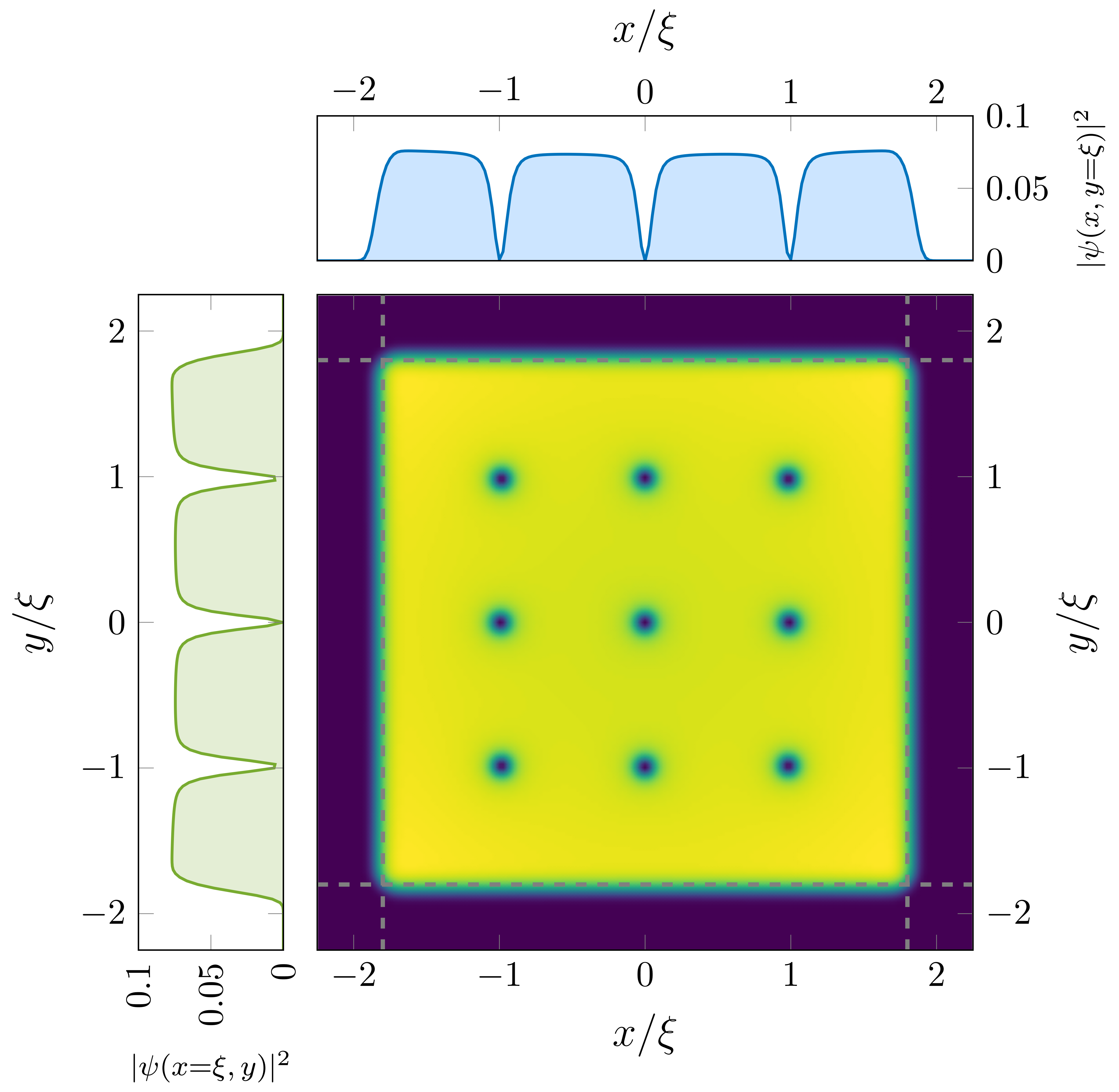

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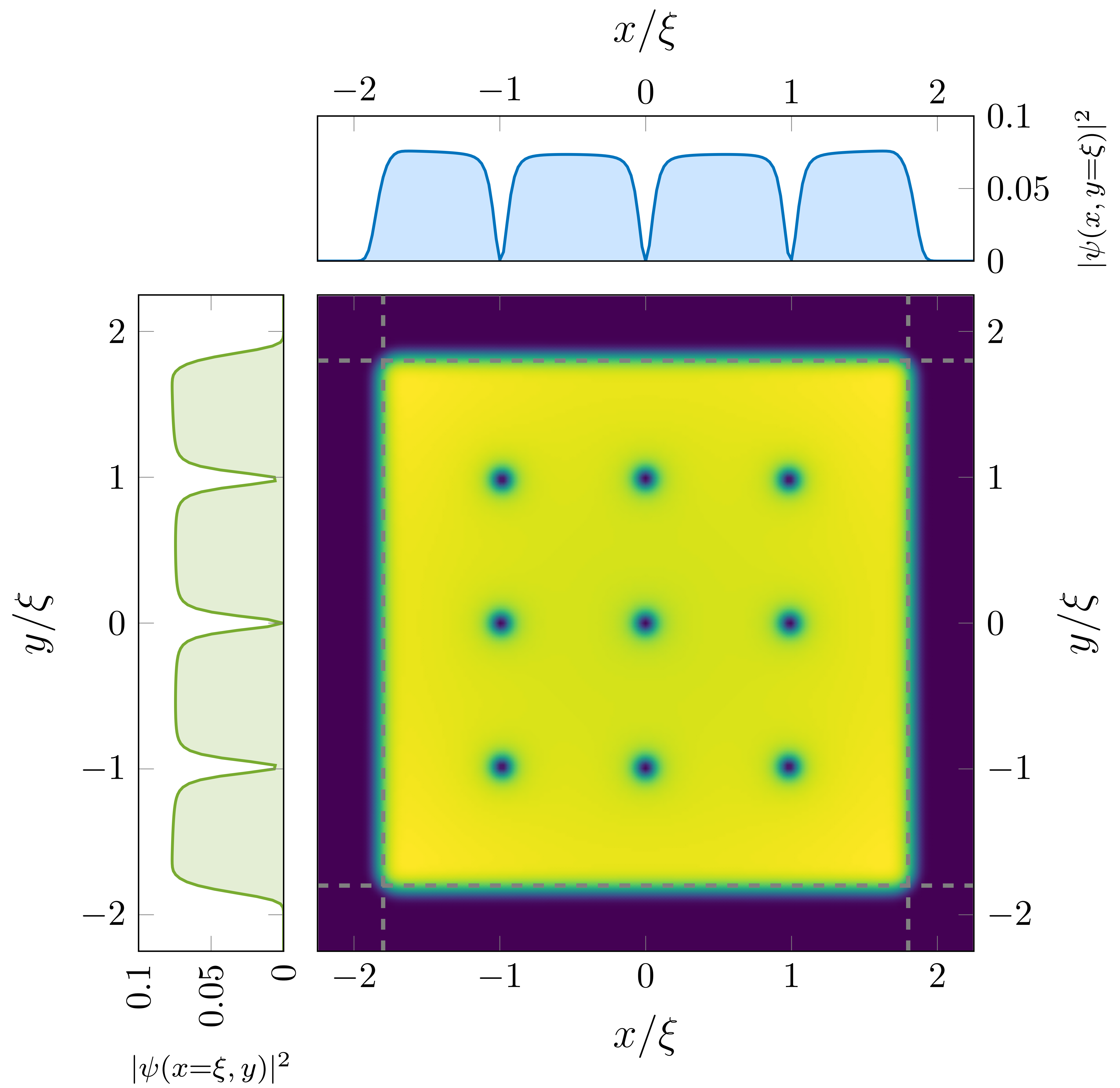

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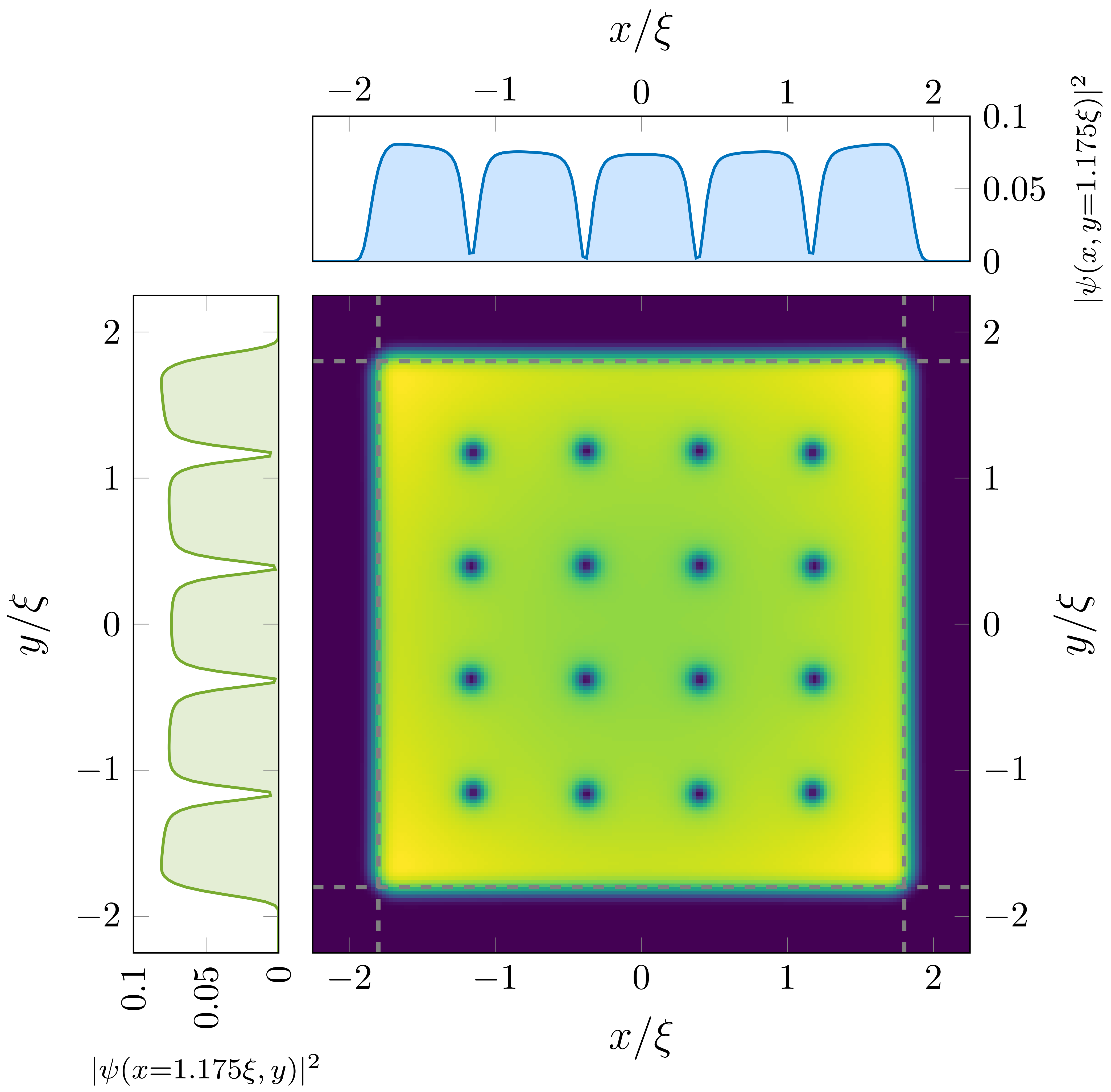

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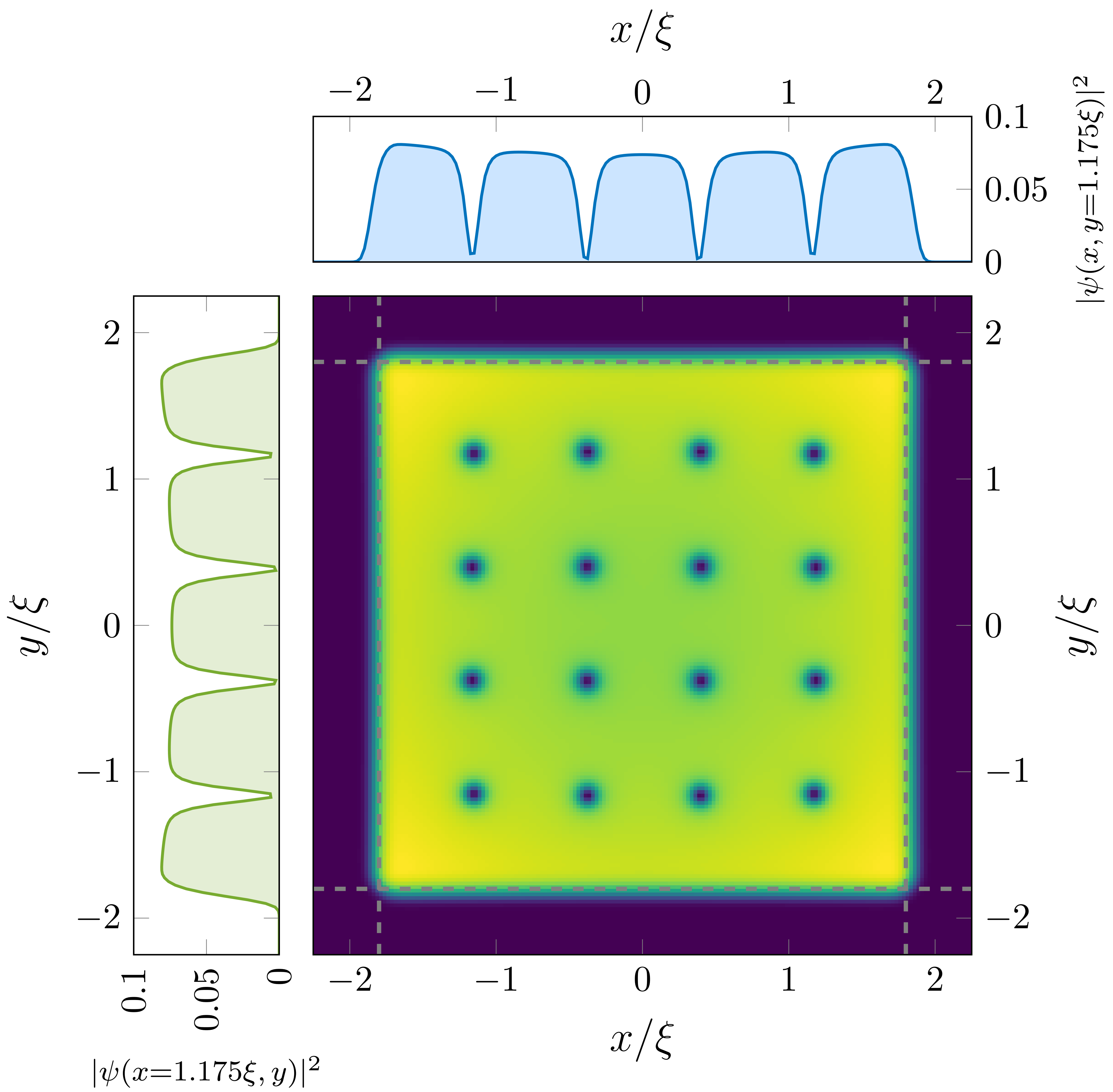

S. K. Adikari, J. Phys.: Condens. Matter **31**, 275401 (2019)

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vortices arrange
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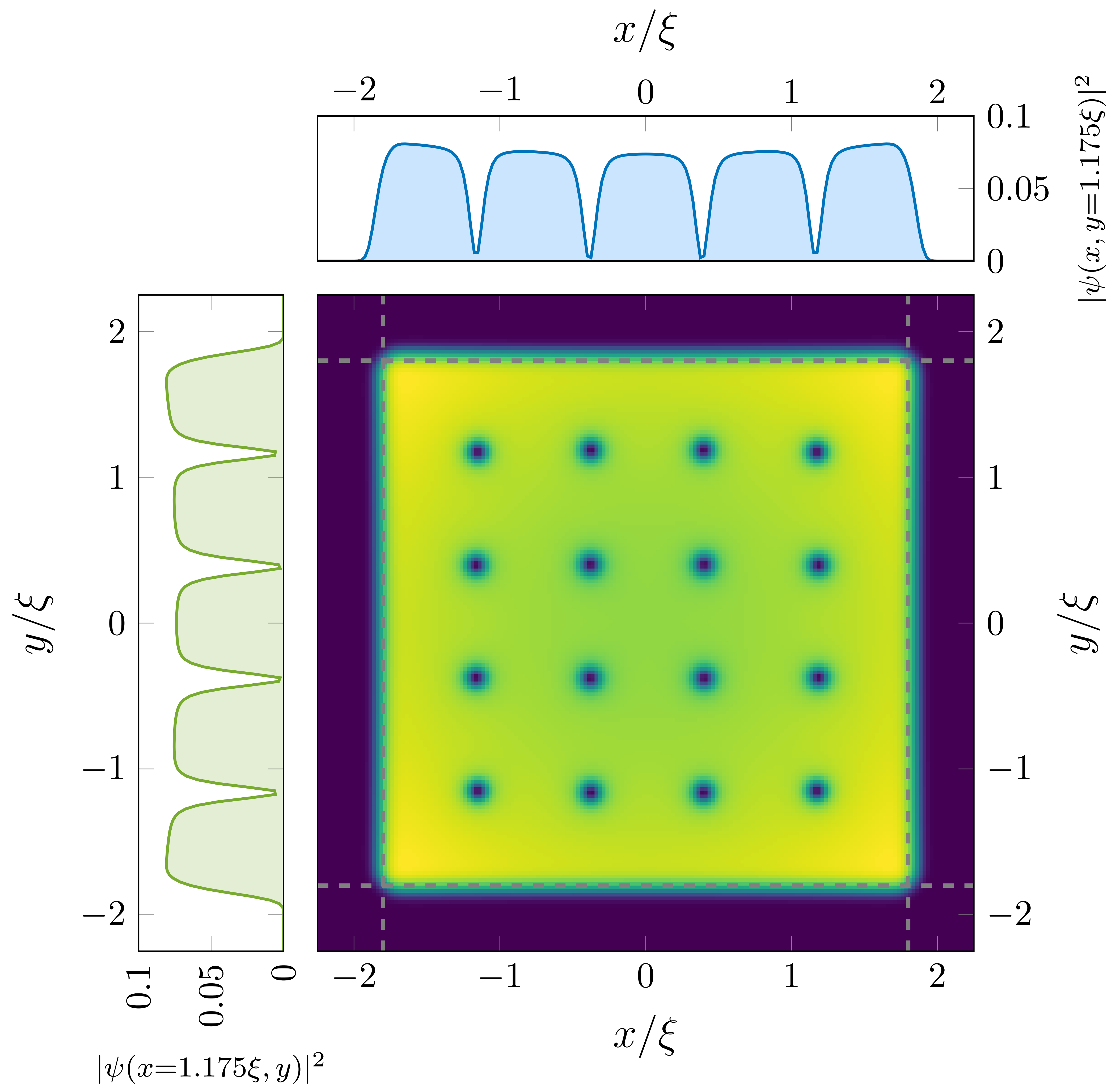

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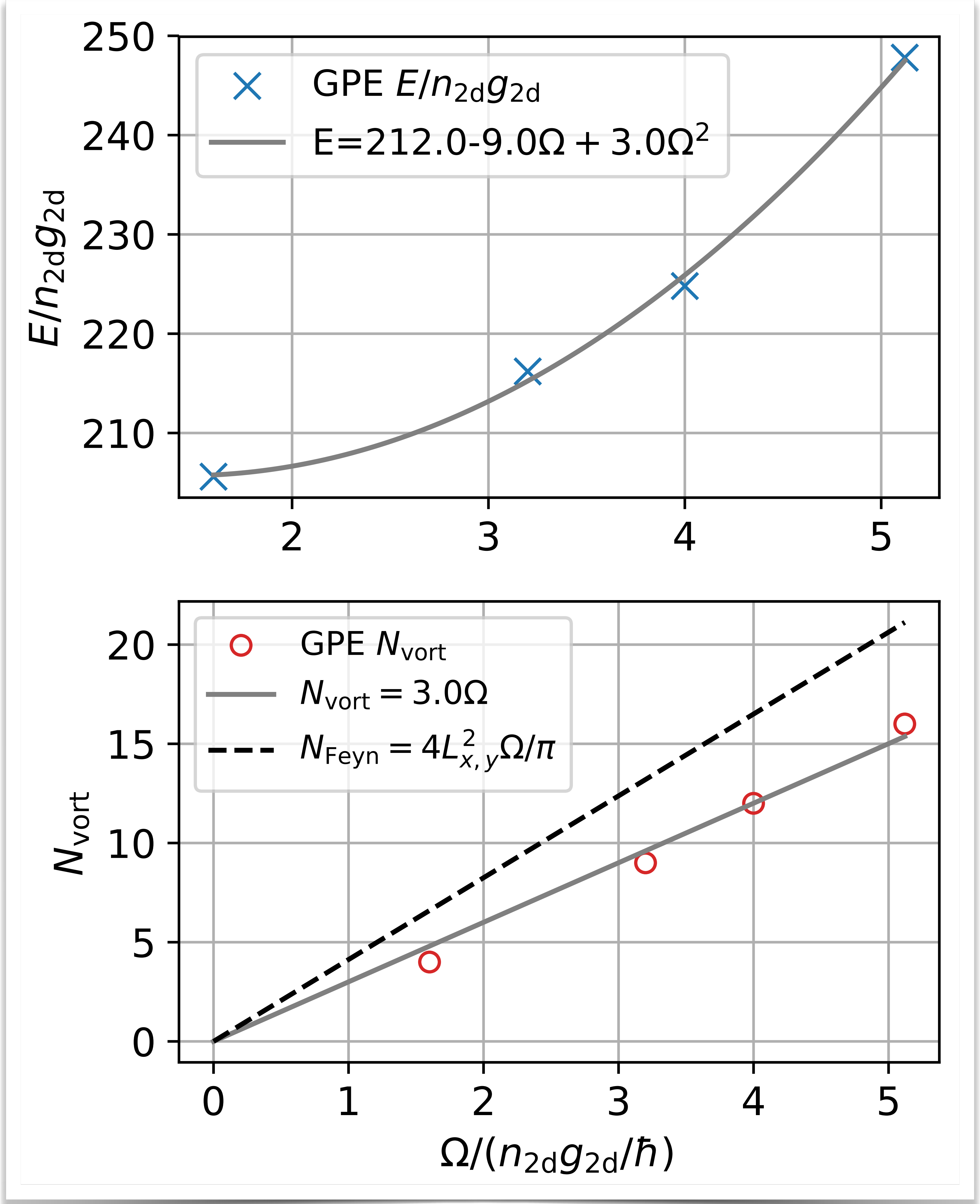

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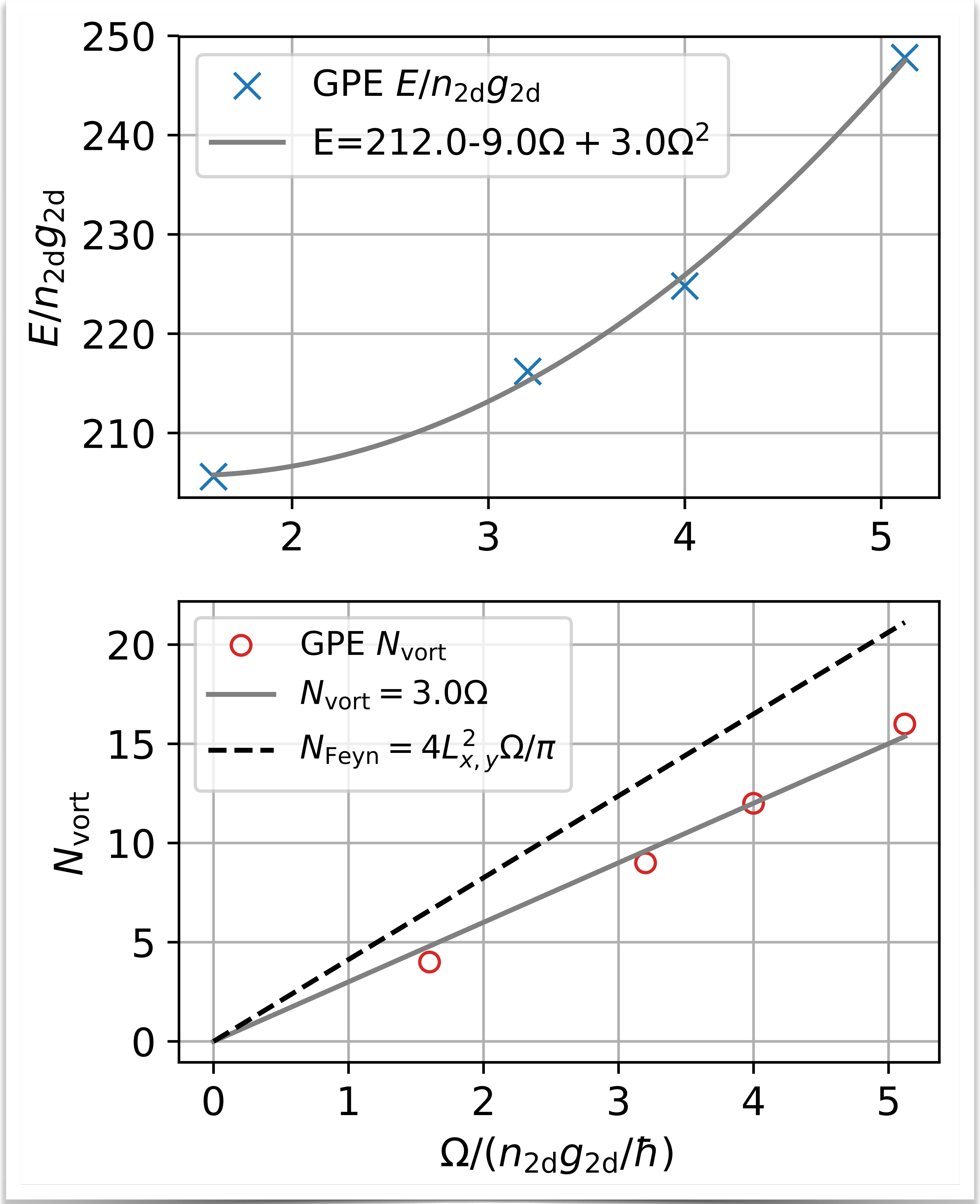

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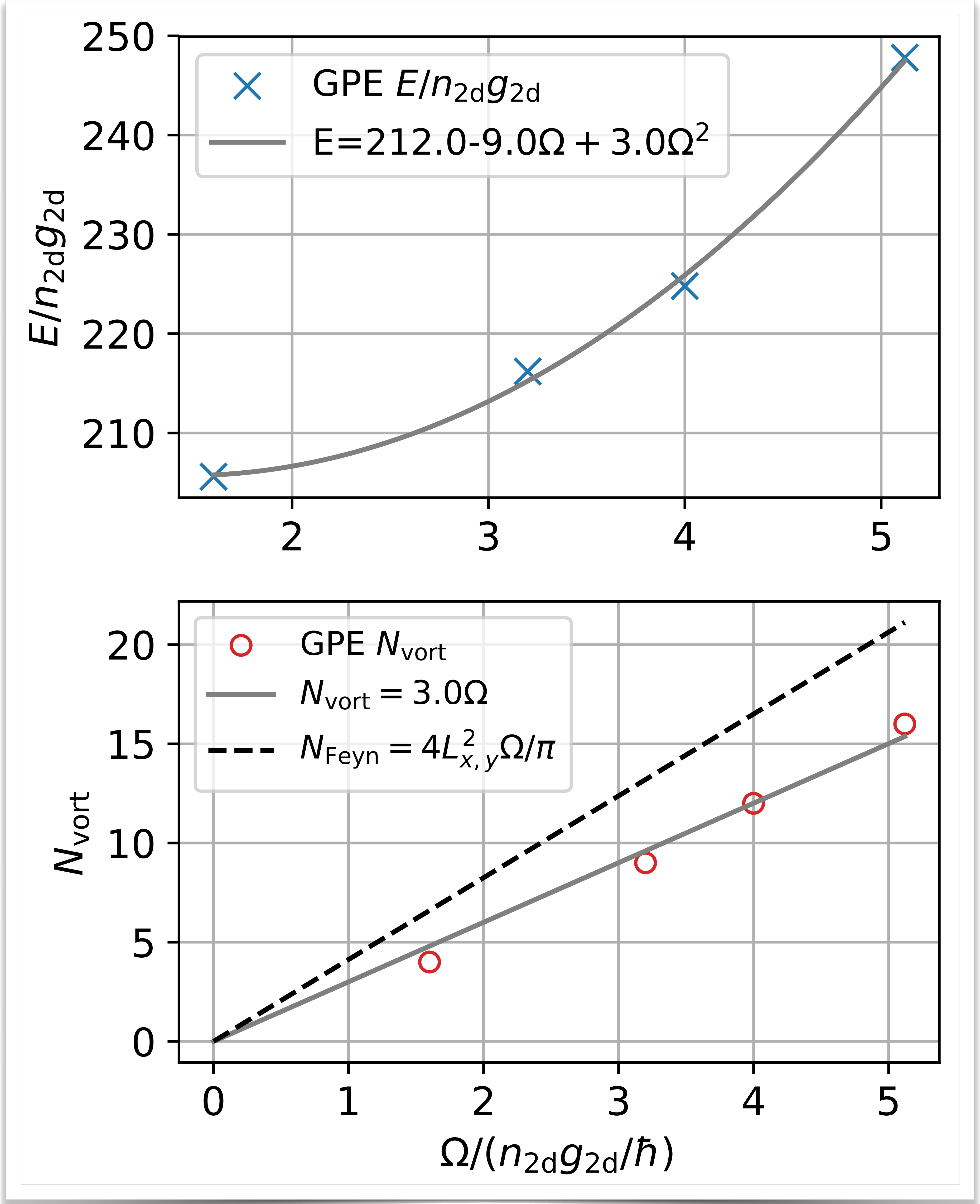

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$$N_{\text{vort}} = \beta_1\Omega$$

$$N_{\text{Feyn}} = \frac{m}{\pi\hbar}(2L_{x,y})^2\Omega$$

R. P. Feynman, Prog. Low. Temp. Phys. **1**, 17 (1955)

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Thank you

questions?

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