Nemaktis: a numerical platform for light propagation in liquid crystals

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REPUBLIKE SLOVENIJE

MARIE CURIE ACTIONS

Outline

Motivations

- Recent advances in LC-based light application: tunable microresonators, micro-optical elements, diffraction gratings...

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Nemaktis: an easy-to-use open-source platform including tools for light propagation in arbitrary birefringent media.

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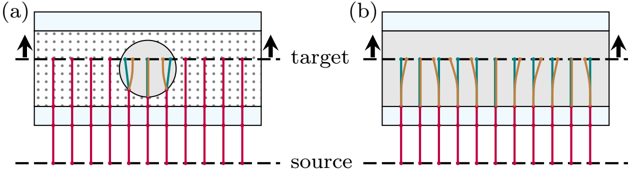
Hamiltonian ray-tracing and energy transport

$$\frac{\mathrm{d}\eta}{\mathrm{d}\bar{s}} = \{\boldsymbol{\eta}, \mathcal{H}\}$$

$$\boldsymbol{\eta} \equiv (\boldsymbol{x}, \boldsymbol{p})$$



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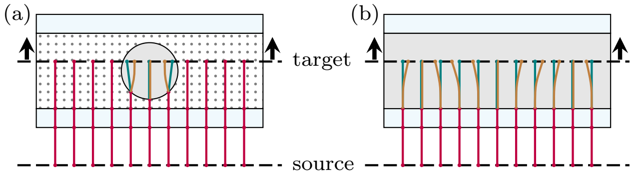
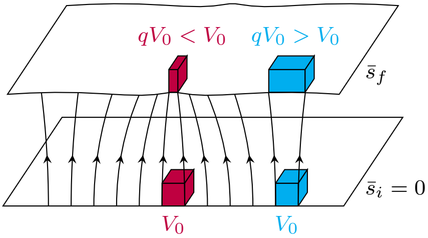
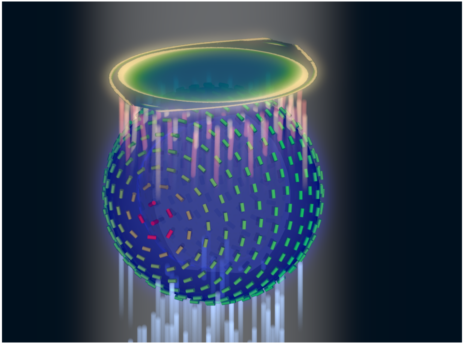
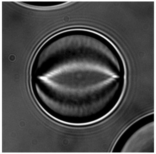


$\mathcal{F}^{(\alpha)} = n_{\text{eff}}\,\sqrt{q}\,E$ conserved along a ray



Application to bright-field microscopy





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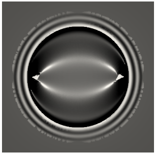

sim.

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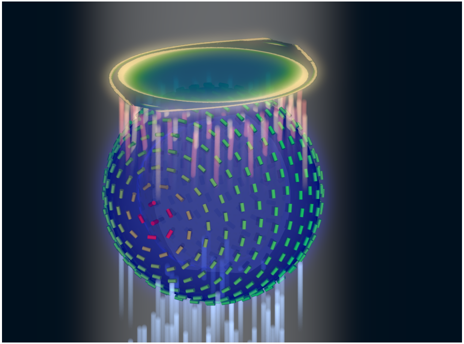

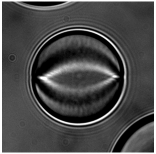

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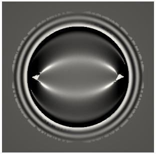

sim.

Advantage: access to ray geometry and natural eigenmodes
Disadvantage: Mauguin regime, caustics

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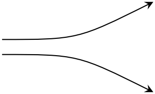
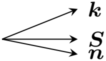


Diffraction ($\sim$ diffusion): redistribution of energy



Beam walk-off: tilt between Poynting vector and wavevector

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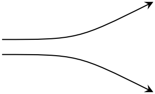

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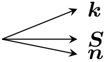

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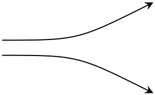

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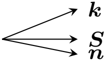

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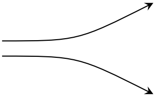

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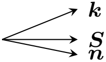

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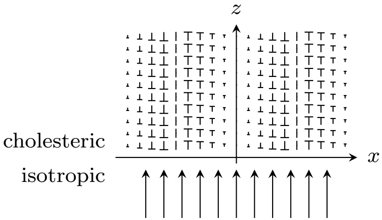
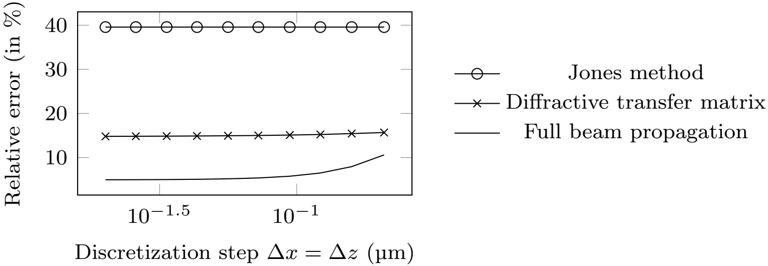
- Possible approximation schemes:
  - ⋆ Jones method: only phase operator
  - ⋆ Diffractive transfer matrix: phase operator + isotropic diffraction.
  - ⋆ Tailored beam-propagation: all contributions except 2D wide-angle corrections.

Numerical error relative to FDTD solution





Comparison with experiment

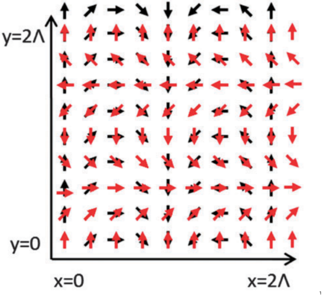
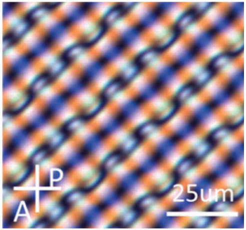


Photo-patterned sample:
I. Nys, J. Beeckman and K. Neyts, Soft Matter **11**, 2015



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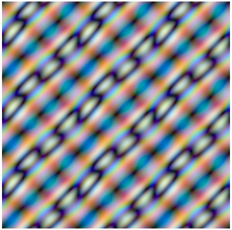

sim. (BPM)

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  - The three backends presented here (C++, python)
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  - An easy-to-use high-level interface (python)
  - A graphical interface for micrographs simulation
- Where to find it: search **Nemaktis** on **github.com** (more advertisement to come)
- Only Linux package for now (Windows and Mac will be supported in the near future)

Thank you for your attention!