

# Spatial Control of Light via Harmonic Potential

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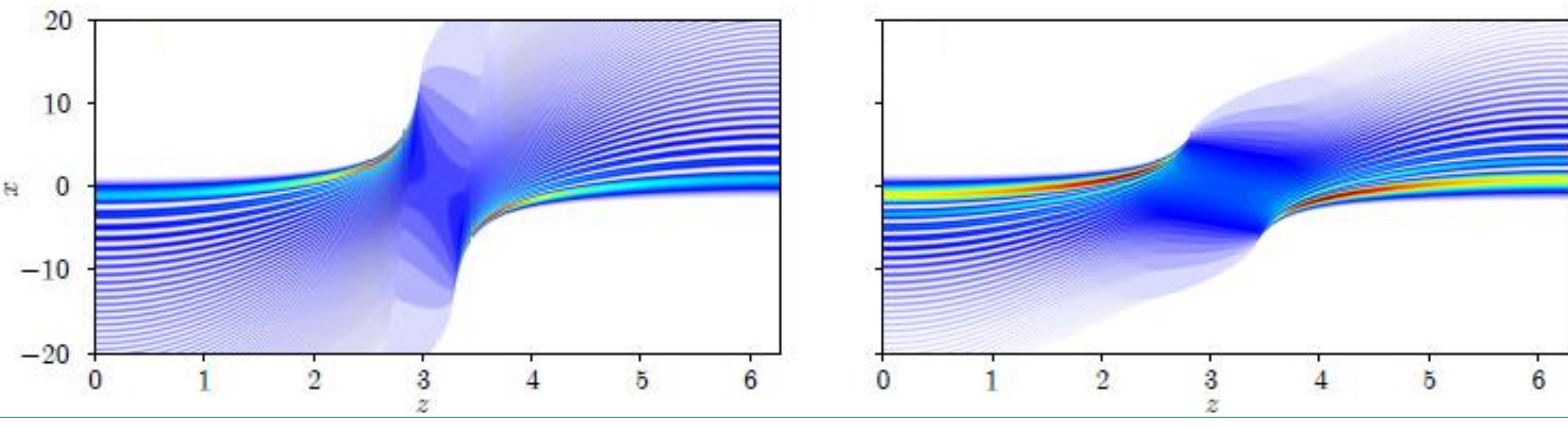
## Introduction

- Model  $i \frac{\partial \psi}{\partial z} + \left[ -\frac{1}{2} \left( -\frac{\partial^2}{\partial x^2} \right)^{\alpha/2} - \frac{1}{2} \beta^2 x^2 \right] \psi = 0$
- $\alpha = 2$ : standard Schrödinger equation
- $1 < \alpha < 2$ : fractional Schrödinger equation

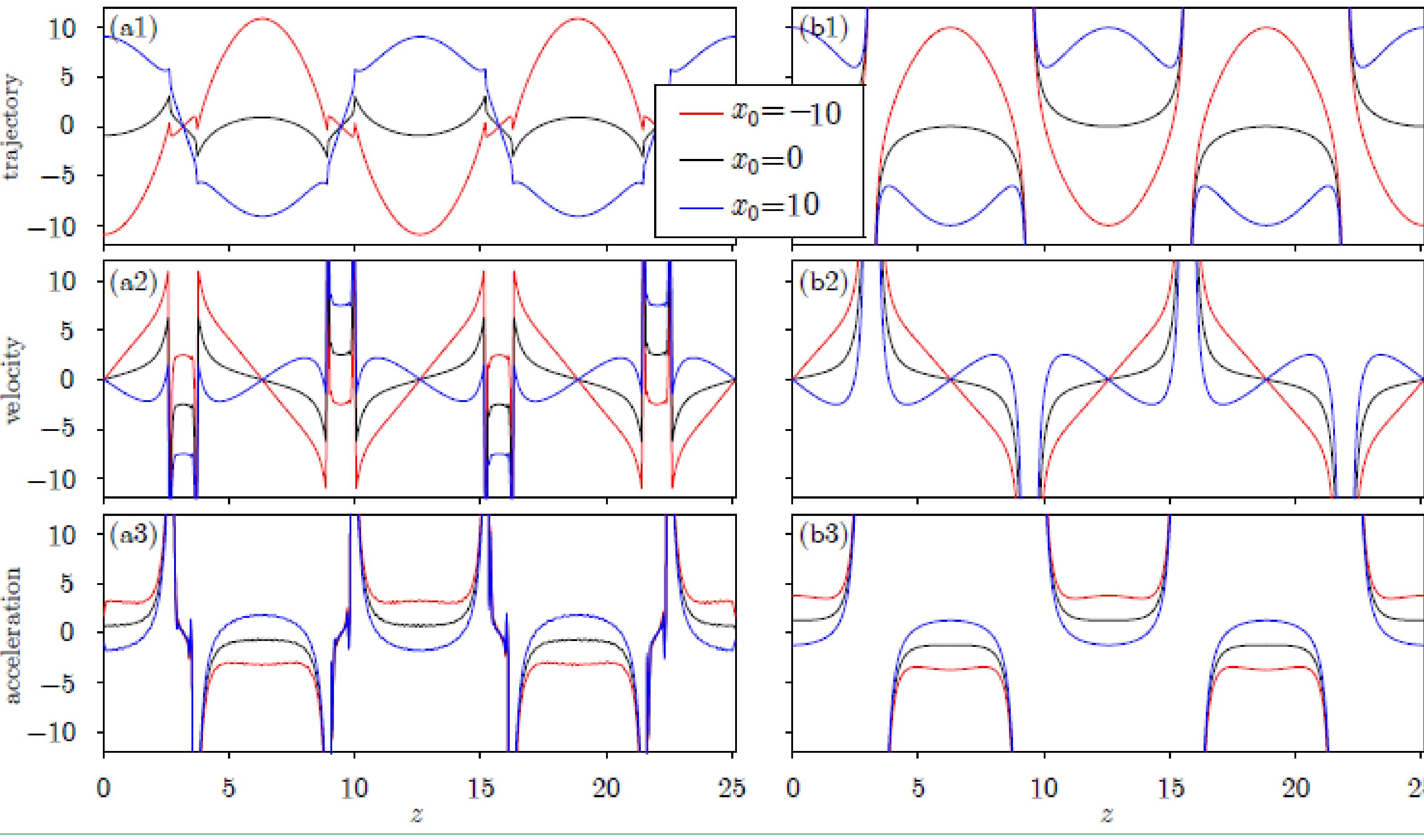
## Airy beams

OE, 23, 10467-10480(2015)

- Intensity distribution of a finite energy Airy beam is asymmetric:  $Ai(x)\exp(ax)$
- As a whole, the oscillation is harmonic
- Periodic inversion, and phase transition
- The region of phase transition is related with  $a$



- The oscillation of the main lobe is anharmonic

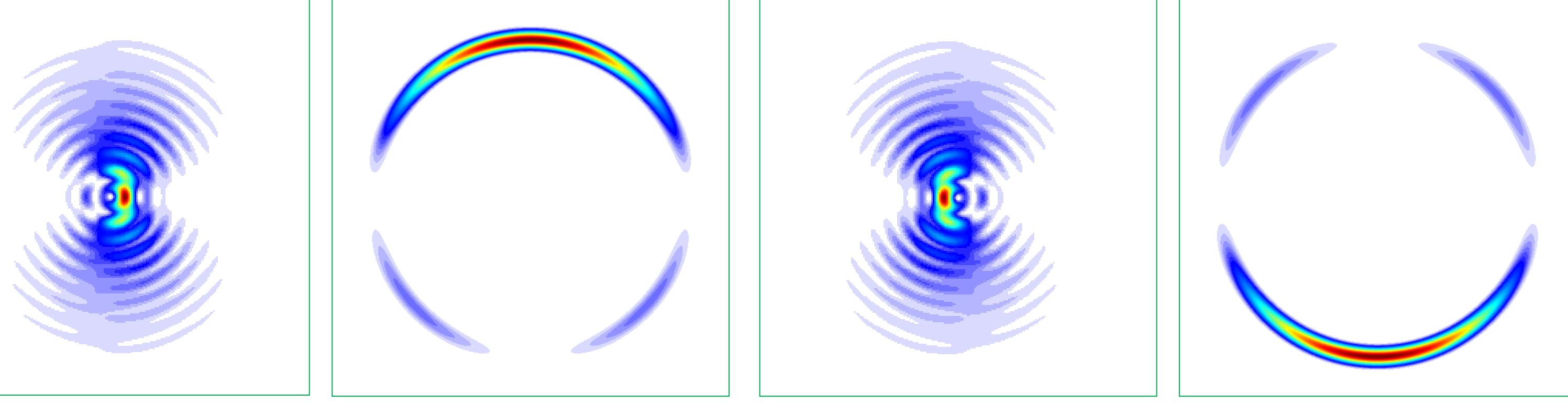


## Optical beams carrying OAM

OL, 40, 3786-3789(2015)

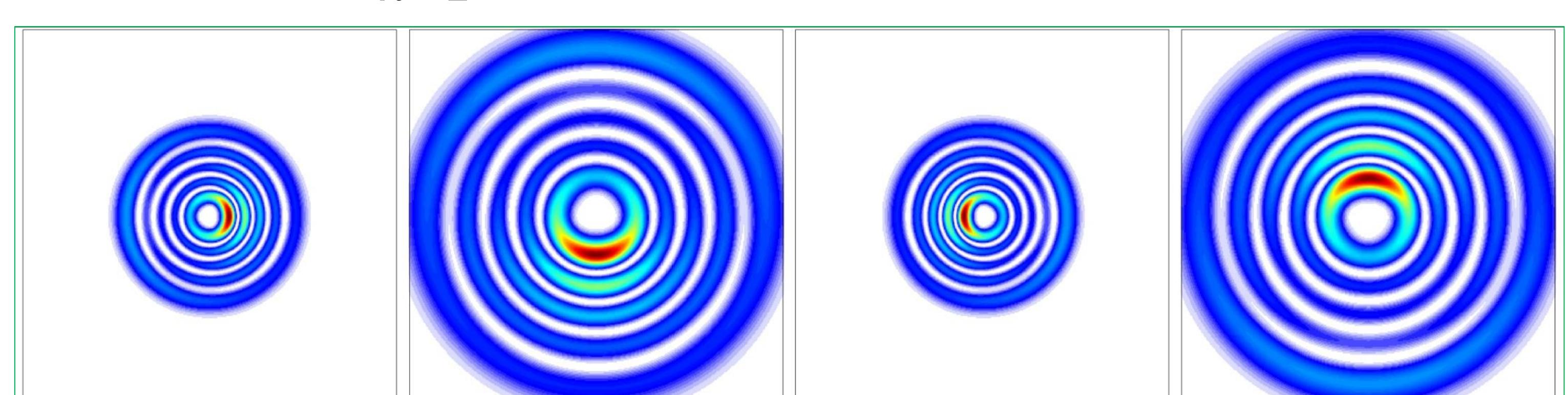
- Bessel-Gaussian beams

$$\psi(r, \theta) = \sum_{n=1}^4 J_n(ar) \exp(in\theta) \exp\left(-\frac{r^2}{\sigma^2}\right)$$



- Laguerre-Gaussian beams

$$\psi(r, \theta) = \sum_{n=1}^4 Ar^n L_n^m(ar^2) \exp(in\theta) \exp\left(-\frac{r^2}{\sigma^2}\right)$$

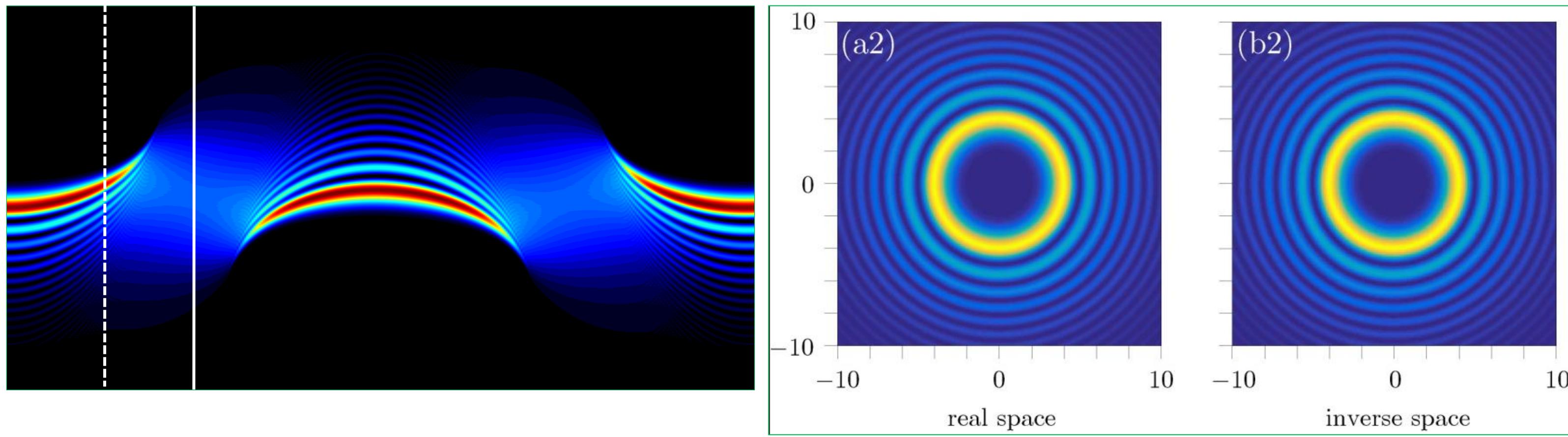


## Self-Fourier transform beams

Ann. Phys., 363, 305-315(2015)

- Fourier transform are themselves

$$\psi(x) = A \int_{-\infty}^{+\infty} \psi(\xi) \exp\left(i \frac{\beta}{2} (\xi^2 + x^2)\right) \exp(-i\sqrt{2}\beta x \xi) d\xi$$



## Fractional Schrödinger equation

Phys. Rev. Lett., 115, 180403(2015)

- Limiting case:  $\alpha = 1$
- Inverse space:  $i \frac{\partial \hat{\psi}}{\partial \xi} + \left( f|k| + \frac{1}{2} \frac{\partial^2}{\partial k^2} \right) \hat{\psi} = 0$
- Analytical propagation and numerical simulations

