Paul Corkum and the Photonics Program at the University of Ottawa

Robert W. Boyd

Department of Physics and
Max-Planck Centre for Extreme and Quantum Photonics
University of Ottawa

The Institute of Optics and
Department of Physics and Astronomy
University of Rochester

Department of Physics and Astronomy
University of Glasgow

The visuals of this talk are available at boydnlo.ca/presentations/

Symposium on Recollision Physics, Montebello QC, May 7 - 11, 2018

Paul Corkum and the University of Ottawa Photonics Program

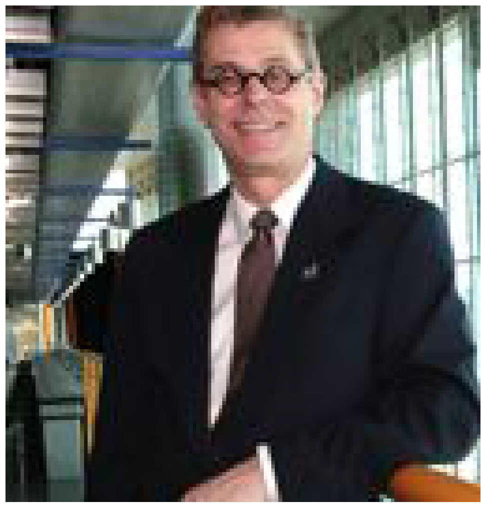
Some highlights:

Paul accepts faculty position at uOttawa (2005)

Paul convinces uOttawa to invest in research in photonics (about 2008)
- Spearheads proposal to recruit a Canada Excellence Research Chair (2008-2009)
- Spearheads effort for research building (ARC) (Constructed 2014-2018)
- Negotiates my coming to Ottawa;
  CERC position includes 3 assistant professors (2010)

Paul helps establish Max Planck Centre at uOttawa (with Leuchs, Berini, and me)
- Max Planck Centre for Extreme and Quantum Photonics

University of Ottawa Nonlinear Photonics Program - Senior Staff



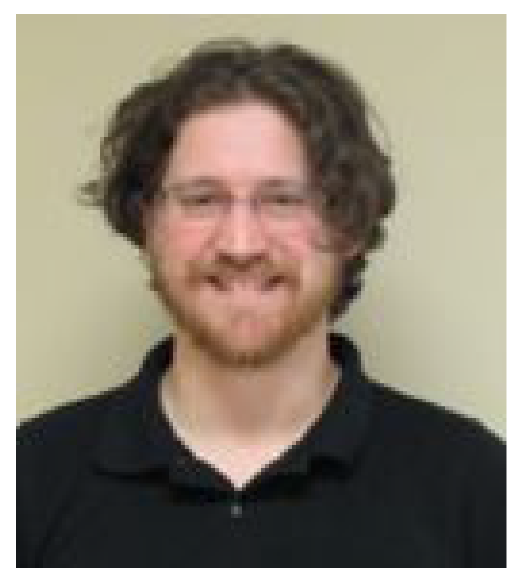
Robert Boyd
CERC

Ksenia Dolgaleva
Asst. Prof.

Jeff Lundeen
Asst. Prof.

Ebrahim Karimi
Asst. Prof.

Gerd Leuchs
Adjunct Prof.



Jeremy Upham
Staff Scientist

Research in Quantum Photonics

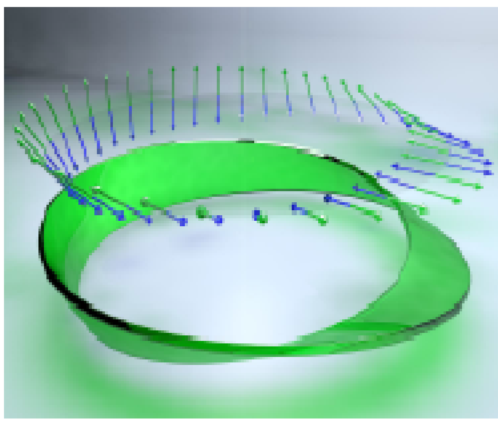
Robert Boyd
Canada Excellence Research Chair in Quantum Nonlinear Optics
University of Ottawa

Our research interests include:

Nanophotonics	Quantum nonlinear optics
Plasmonics	Optical methods for quantum information
Photonic crystals	Biophotonics
Photonic device	Nonlinear optics of atomic vapors
Applications of slow and fast light	Optical chirality and structure surfaces

Presented at the 5th Annual Meeting of the Canada Excellence Research Chairs, April 13-14 2015, University of Waterloo

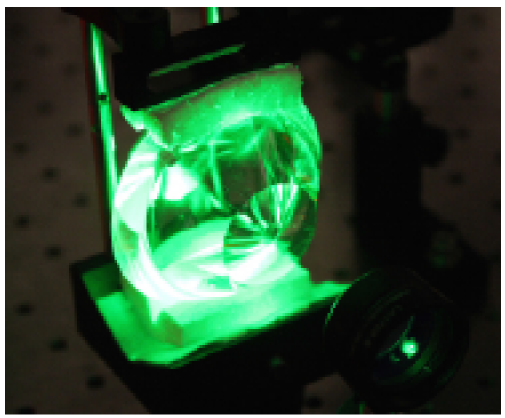
Quirky Optical phenomena



Optica **3**, 351 (2016).

Science **347**, 964 (2015).

Novel Optical Devices

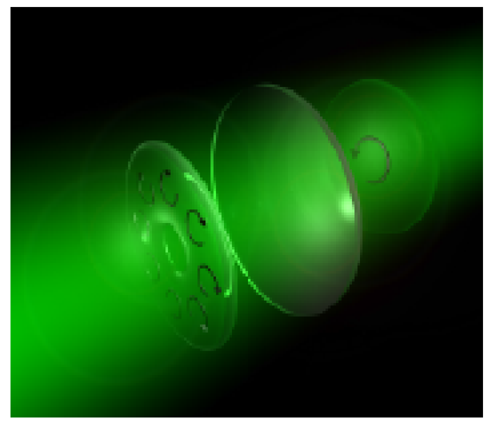


Optica **2**, 900 (2015).

New Journal of Physics **16**, 123006 (2014).

Light: Sci. & Appl. **3**, e167 (2014).

Foundation of QM

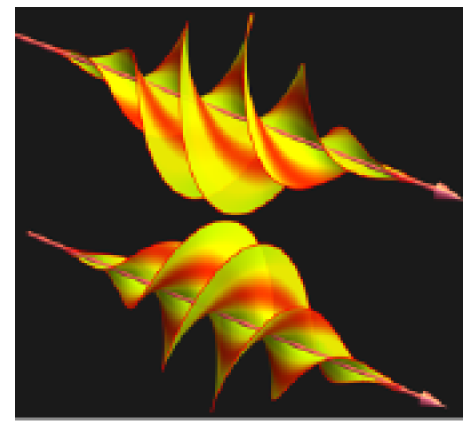


Science 350, 1172 (2015).

Physical Review X **5**, 041006 (2015).

Science Advances **1**, e1500087 (2015).

Twisted Matter Waves



Nature Physics **11**, 629 (2015).

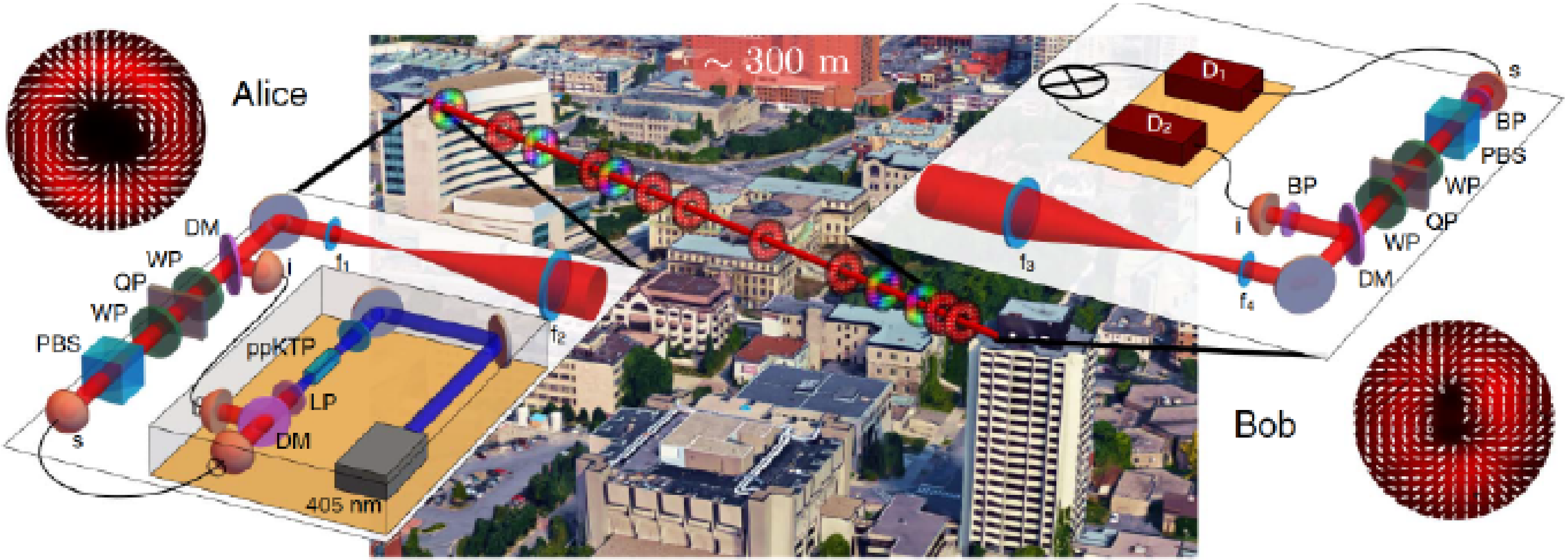
Physical Review Letters **114**, 034801 (2015).

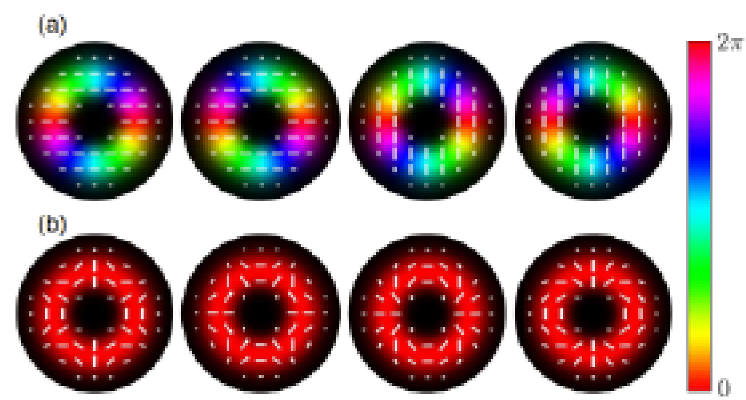
Physical Review X **4**, 011013 (2014).

optica

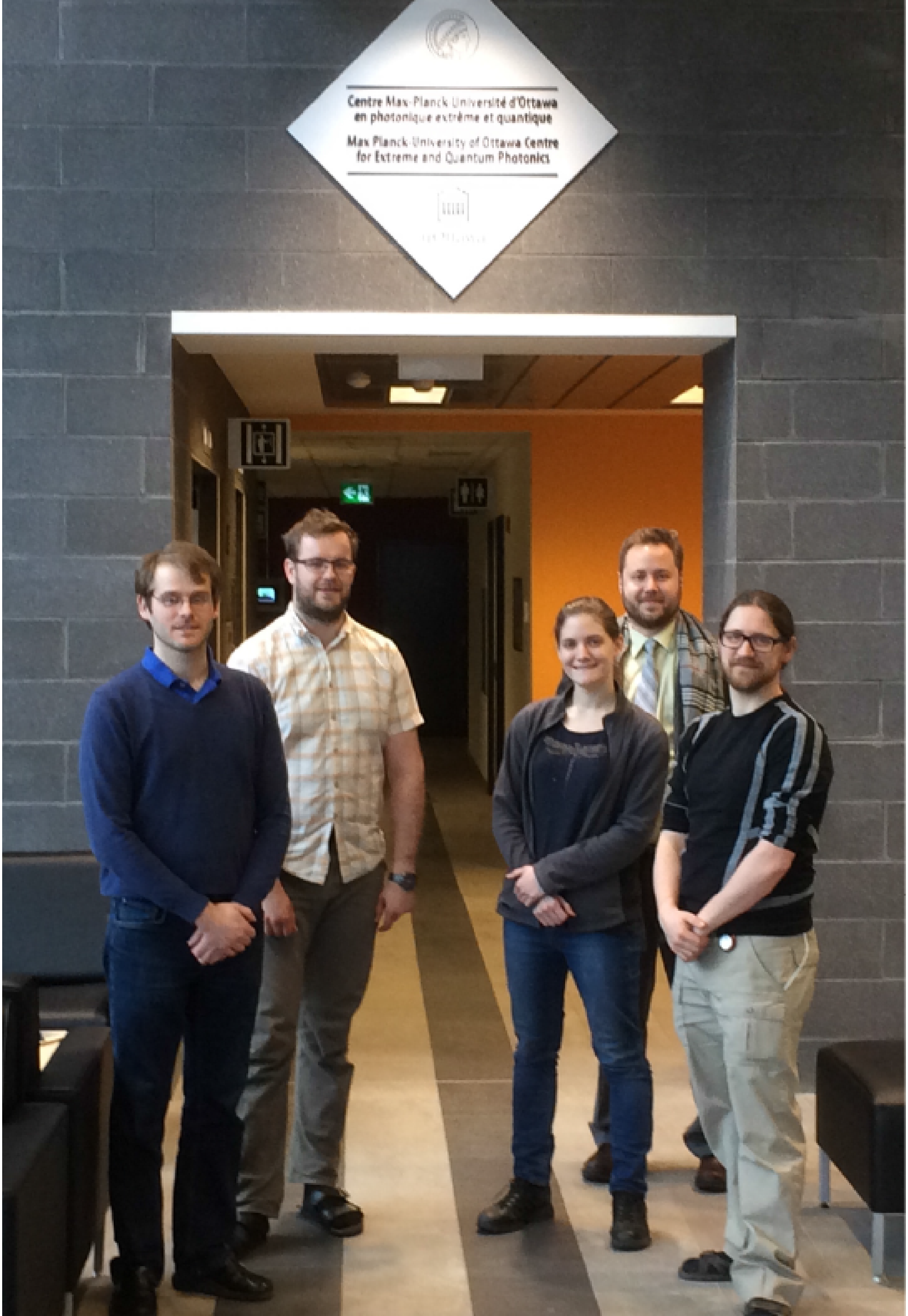
High-dimensional intracity quantum cryptography with structured photons

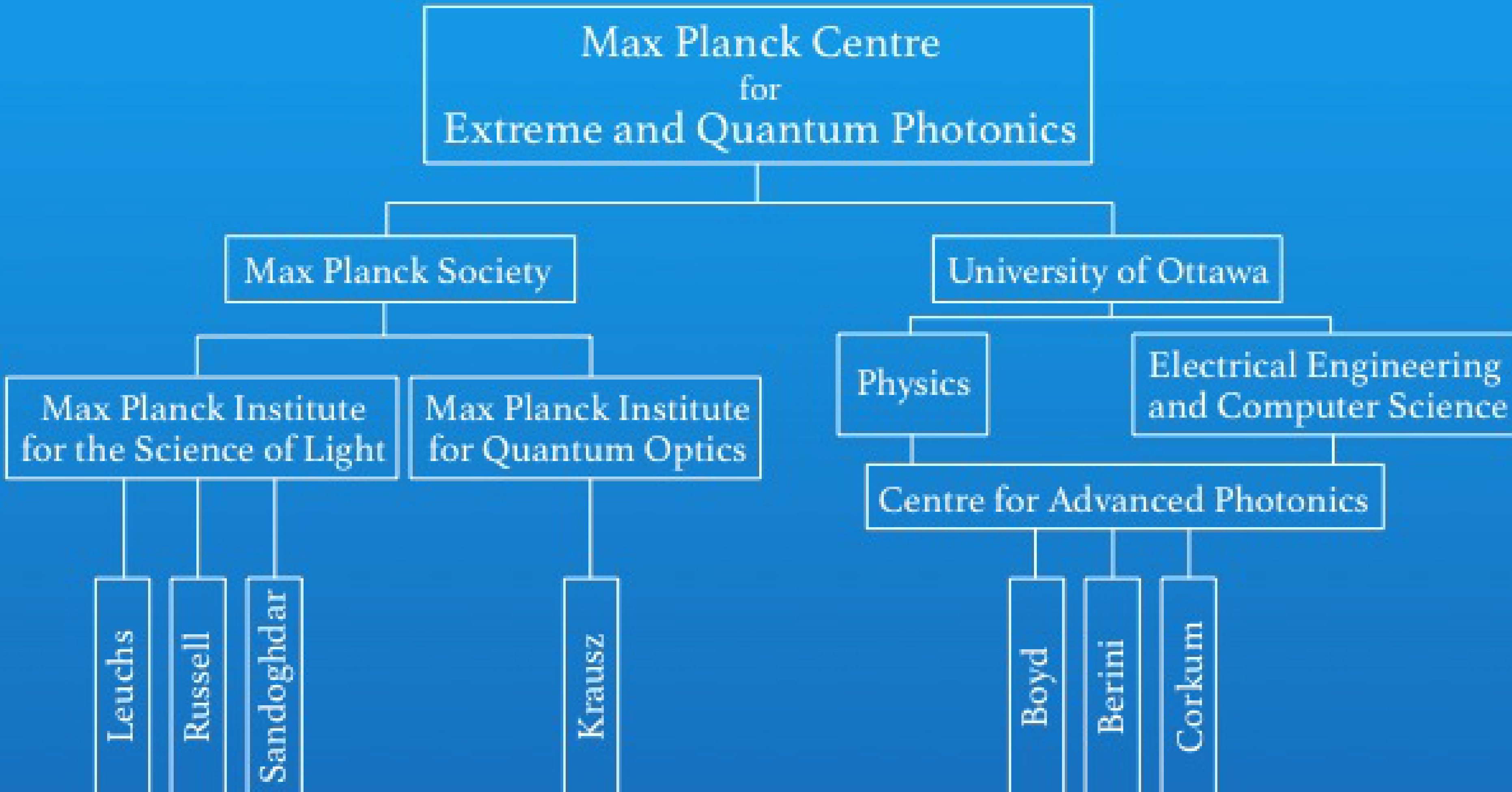
Alicia Sit,[1] Frédéric Bouchard,[1] Robert Fickler,[1] Jérémie Gagnon-Bischoff,[1] Hugo Larocque,[1] Khabat Heshami,[2] Dominique Elser,[3,4] Christian Peuntinger,[3,4] Kevin Günthner,[3,4] Bettina Heim,[3,4] Christoph Marquardt,[3,4] Gerd Leuchs,[1,3,4] Robert W. Boyd,[1,5] and Ebrahim Karimi[1,6,*]



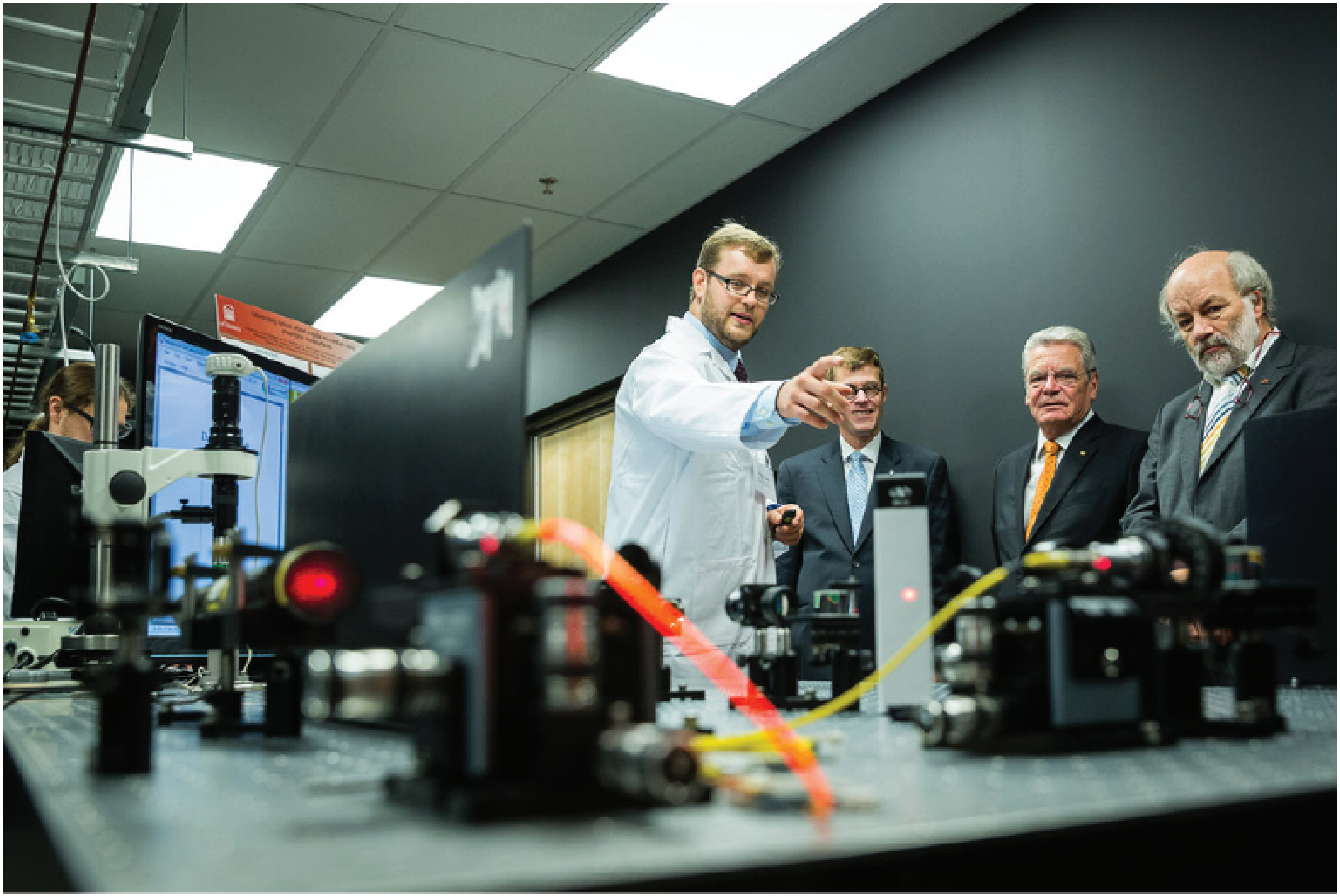


Optica 4, 1006 (2017).


Centre Max-Planck Université d'Ottawa
en photonique extrême et quantique
Max Planck-University of Ottawa Centre
for Extreme and Quantum Photonics


Max Planck Centre
for
Extreme and Quantum Photonics
Max Planck Society
University of Ottawa
Max Planck Institute for the Science of Light
Max Planck Institute for Quantum Optics
Physics
Electrical Engineering and Computer Science
Centre for Advanced Photonics
Leuchs
Russell
Sandoghdar
Krausz
Boyd
Berini
Corkum

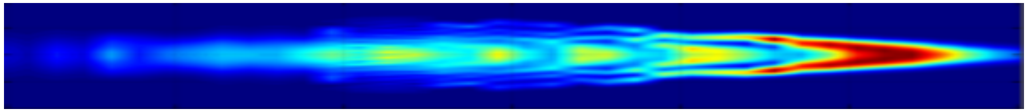
A Laboratory Visitor



Extreme Photonics

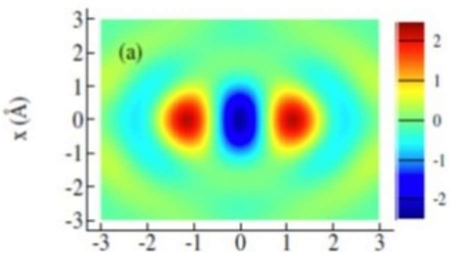
Research themes

- Attosecond pulse generation and measurement

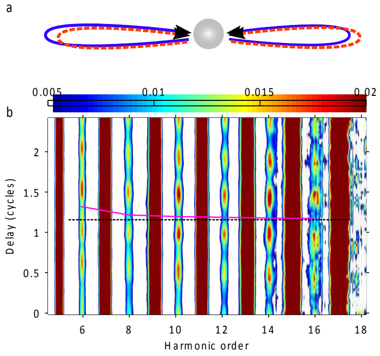


- Producing and controlling soft X-ray beams
- Extreme nonlinearity
- Ultrafast measurements
- Characterizing Quantum Systems

Paul Corkum



Measuring the HOMO Orbital of N_2



Linking High harmonic gases and solids.

- Mass spectrometry

Plasma Perspective on Strong-Field Multiphoton Ionization

P. B. Corkum

National Research Council of Canada, Ottawa, Ontario, Canada K1A 0R6

(Received 9 February 1993)

During strong-field multiphoton ionization, a wave packet is formed each time the laser field passes its maximum value. Within the first laser period after ionization there is a significant probability that the electron will return to the vicinity of the ion with very high kinetic energy. High-harmonic generation, multiphoton two-electron ejection, and very high energy above-threshold-ionization electrons are all consequences of this electron-ion interaction. One important parameter which determines the strength of these effects is the rate at which the wave packet spreads in the direction perpendicular to the laser electric field; another is the laser polarization. These will be crucial parameters in future experiments.

Some features of this publication:

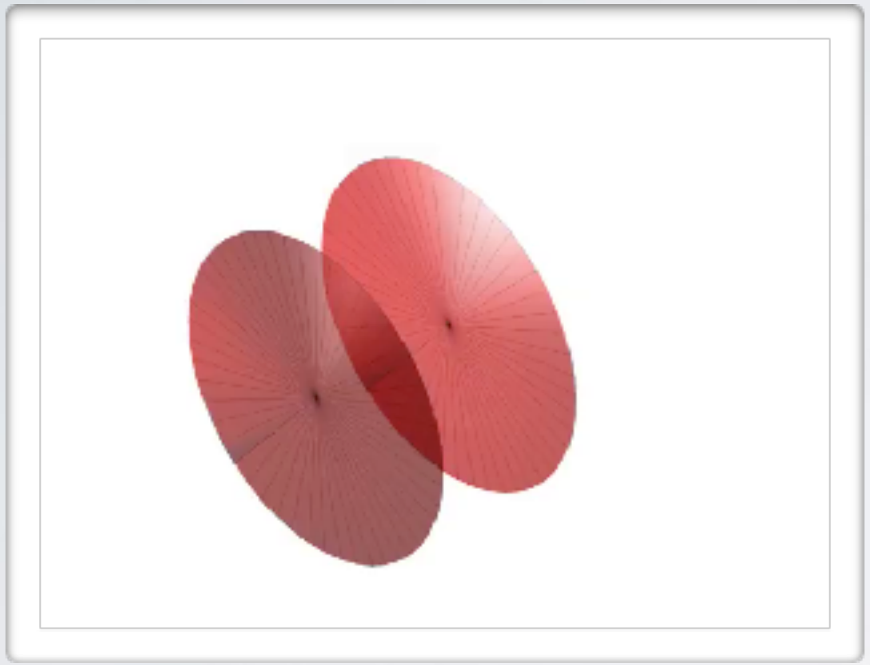
- The term "three step model" never appears.
- The word "recombination" never appears.
- The word "recollision" never appears.

CREATING HIGH-HARMONIC BEAMS WITH CONTROLLED ORBITAL ANGULAR MOMENTUM

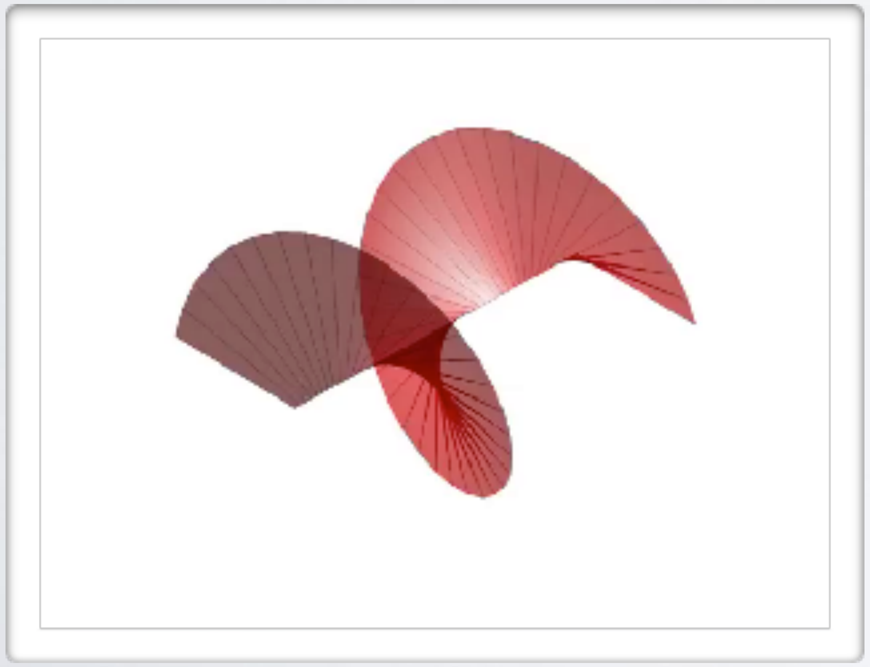
Genevieve Gariepy, Jonathan Leach, Kyung Taec Kim, T.J. Hammond, E. Frumker, Robert W. Boyd, Paul B. Corkum

University of Ottawa
National Research Council of Canada

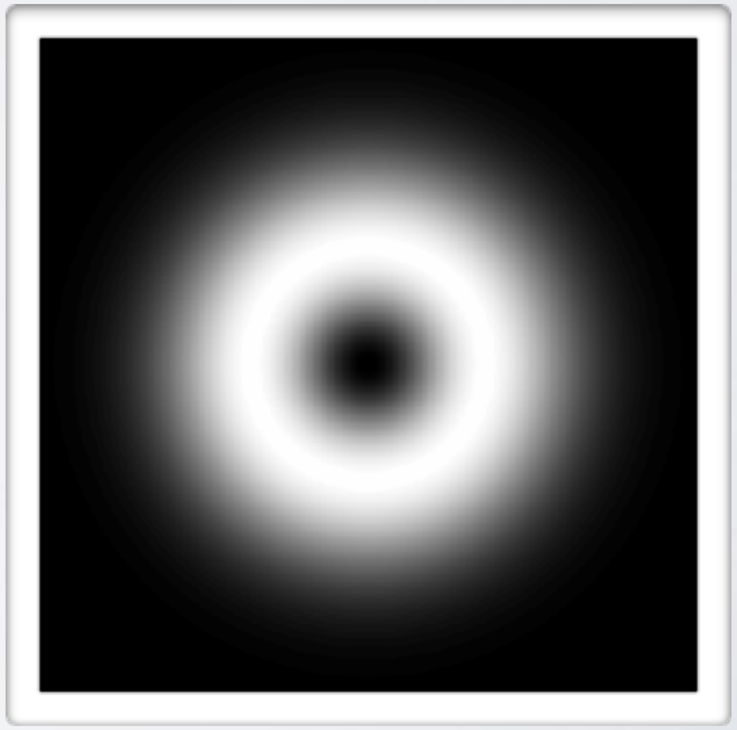
ORBITAL ANGULAR MOMENTUM (OAM)



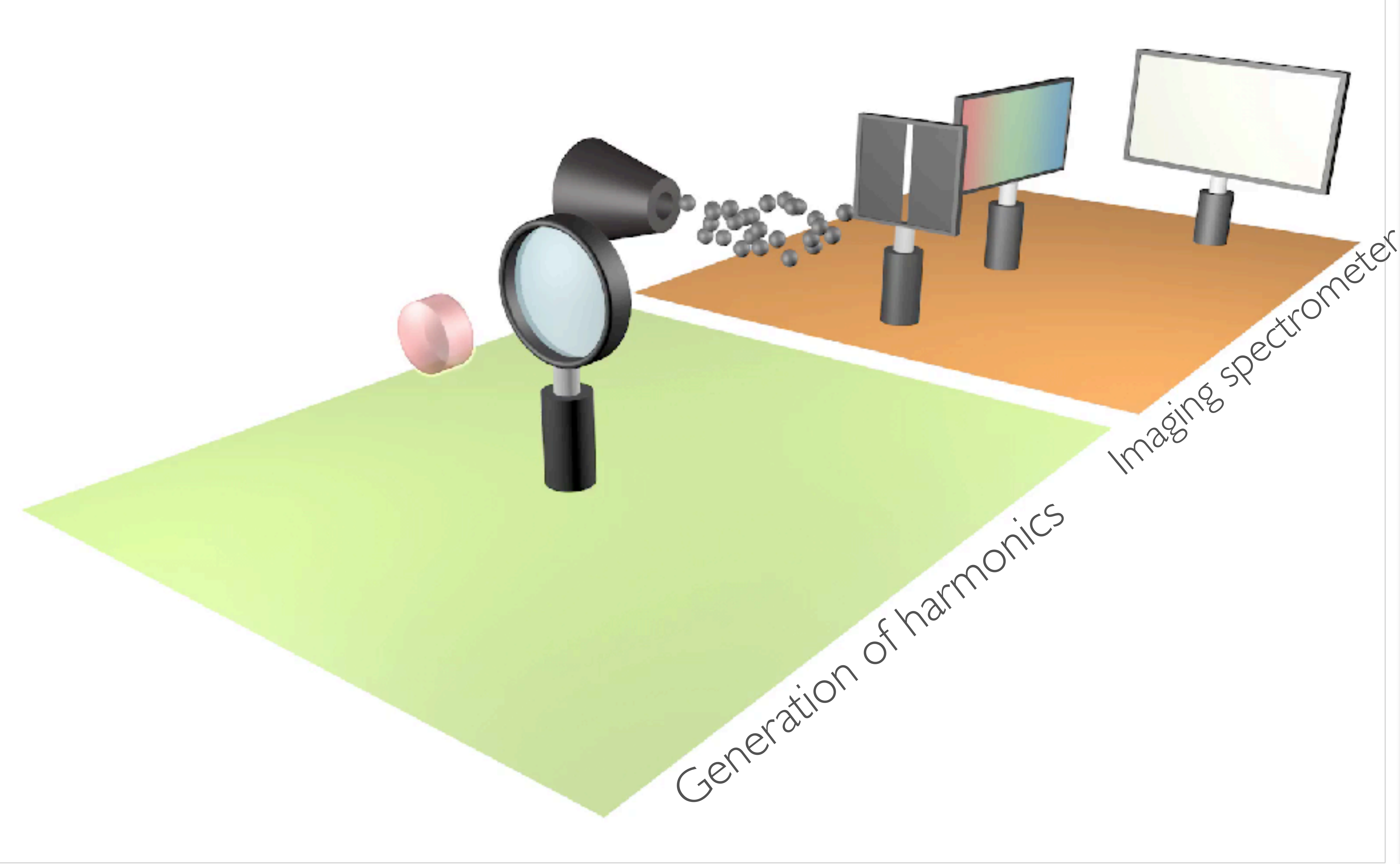
Phase



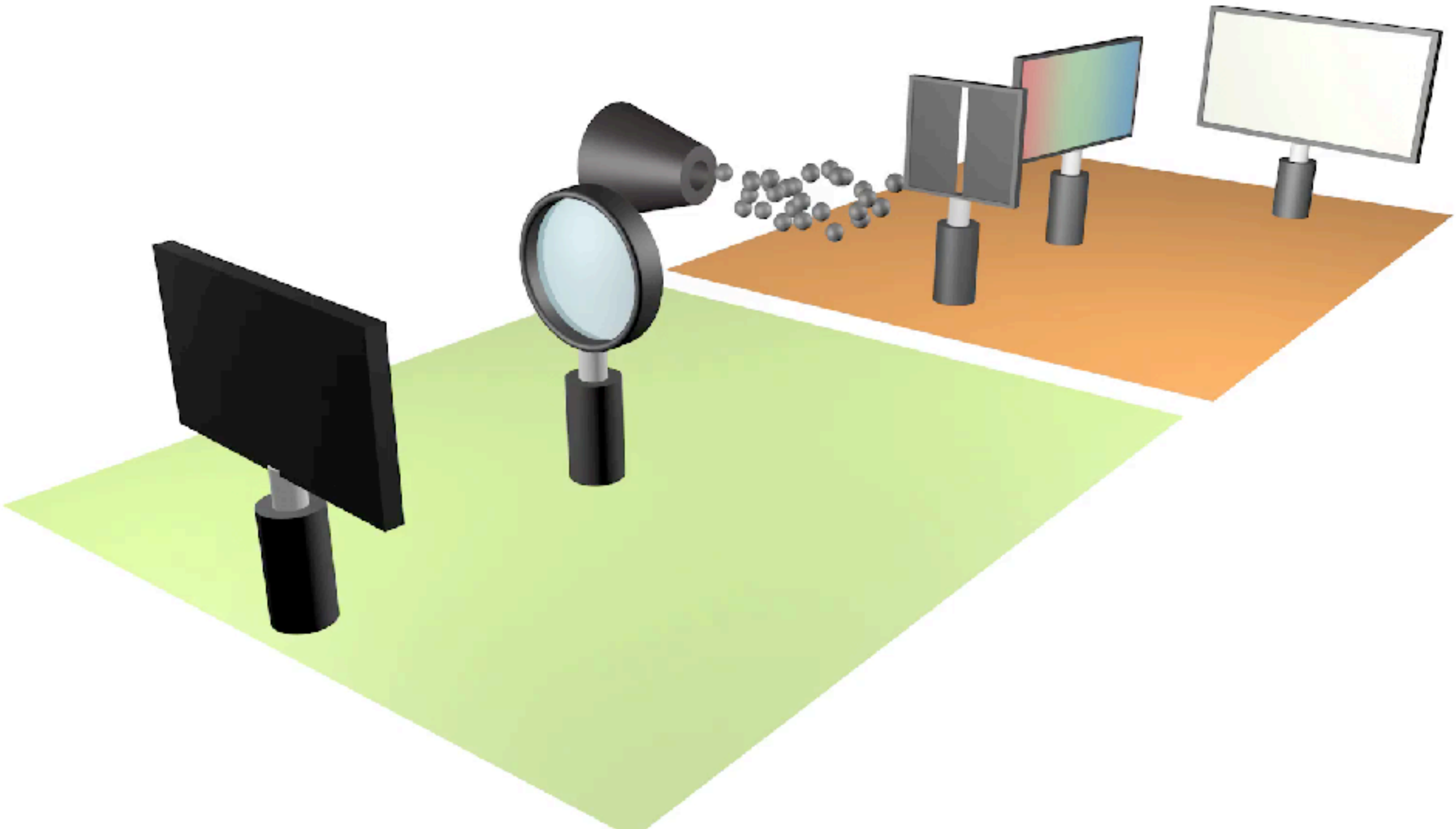
Intensity



1. GENERATE HIGH-HARMONICS

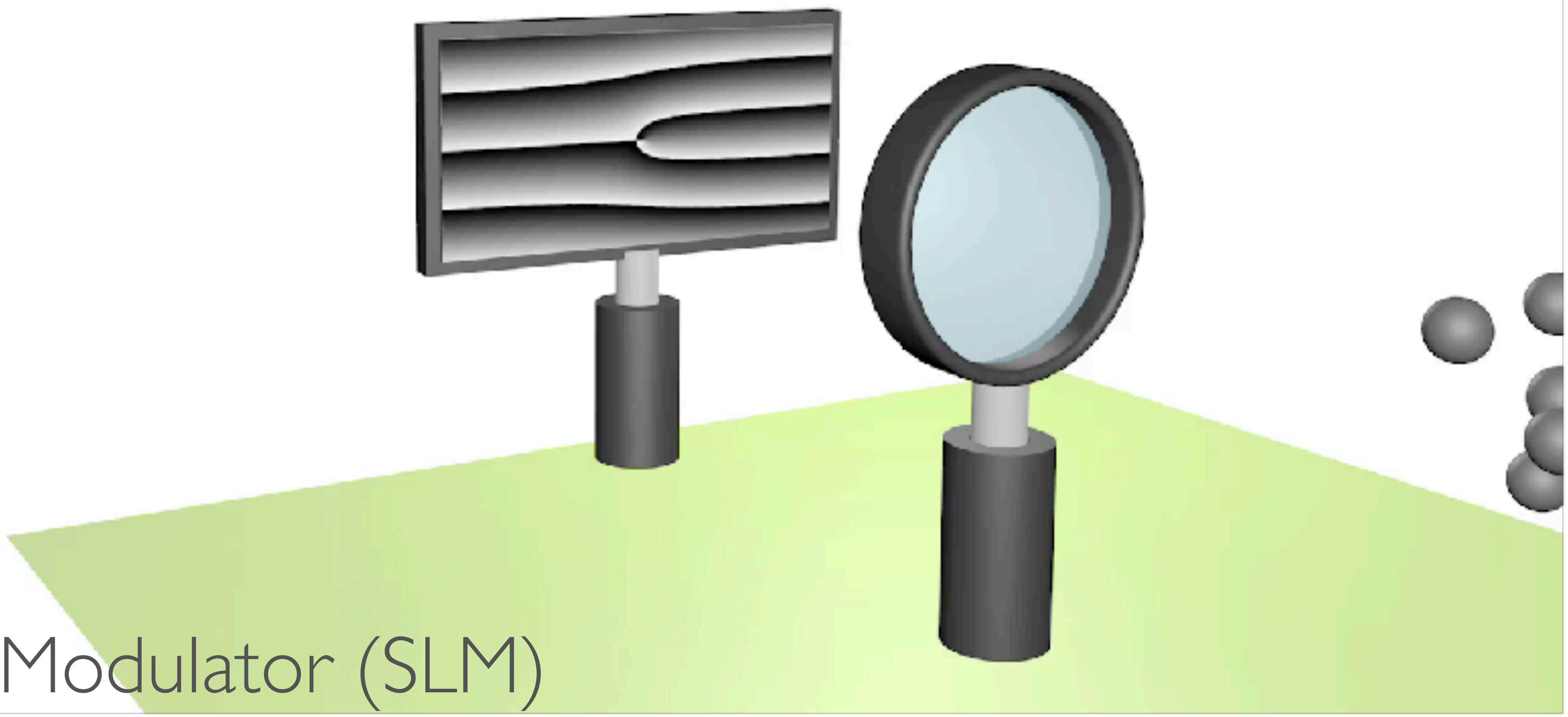


2. PUT SOME OAM IN THERE



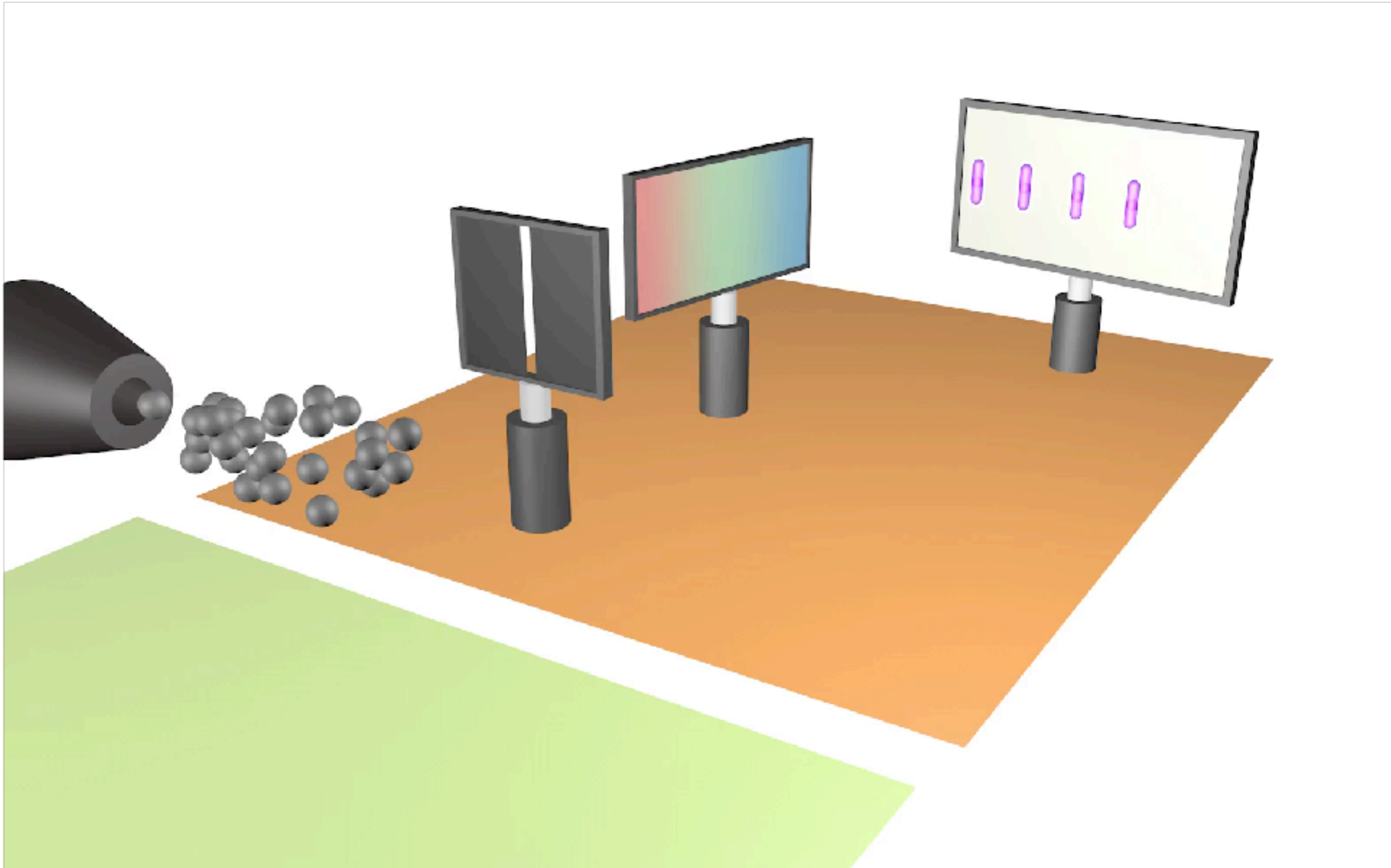
Spatial Light Modulator (SLM)

3. GENERATE HARMONICS WITH OAM

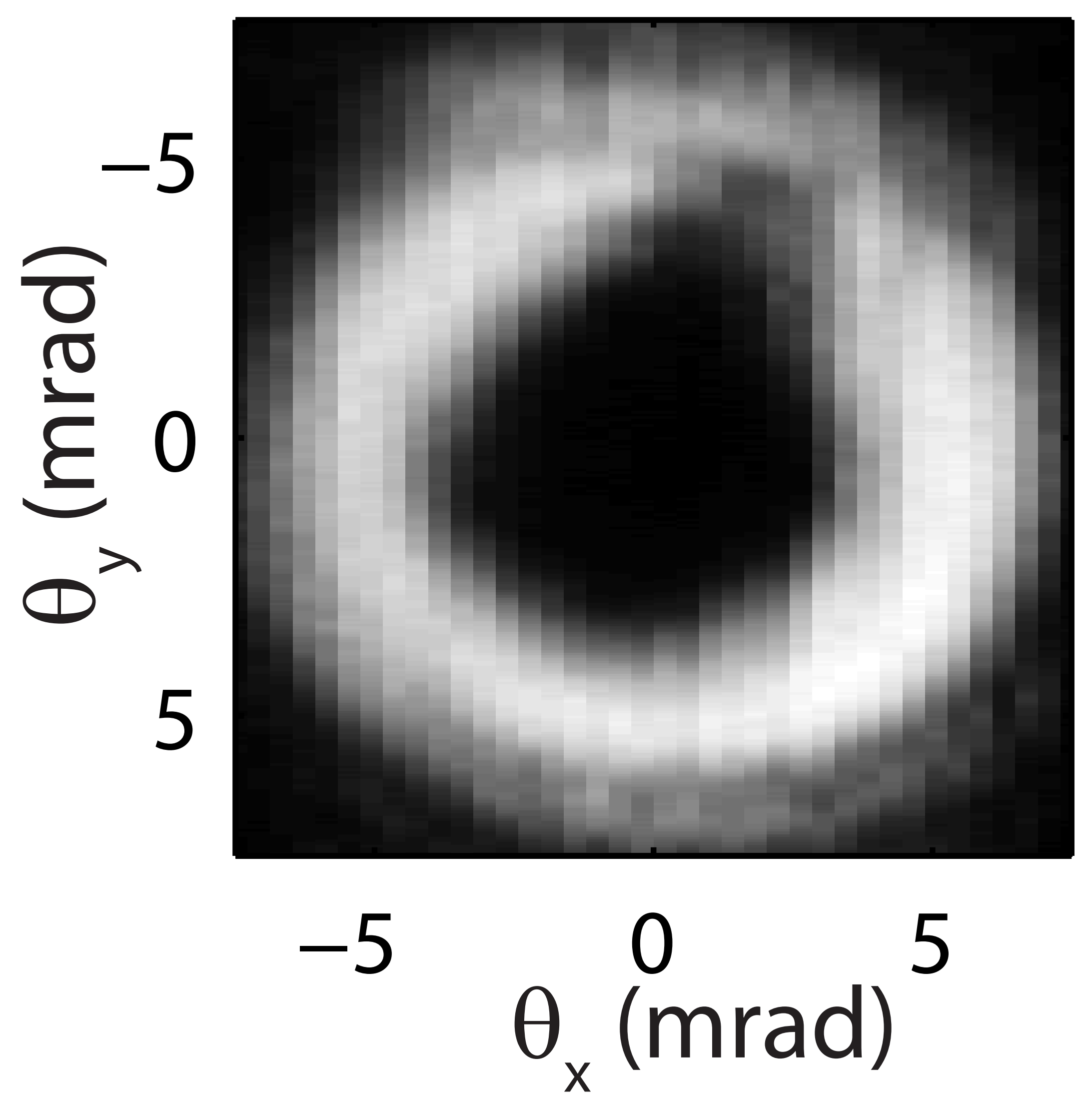


Spatial Light Modulator (SLM)

4. RECOVERING BEAM PROFILES

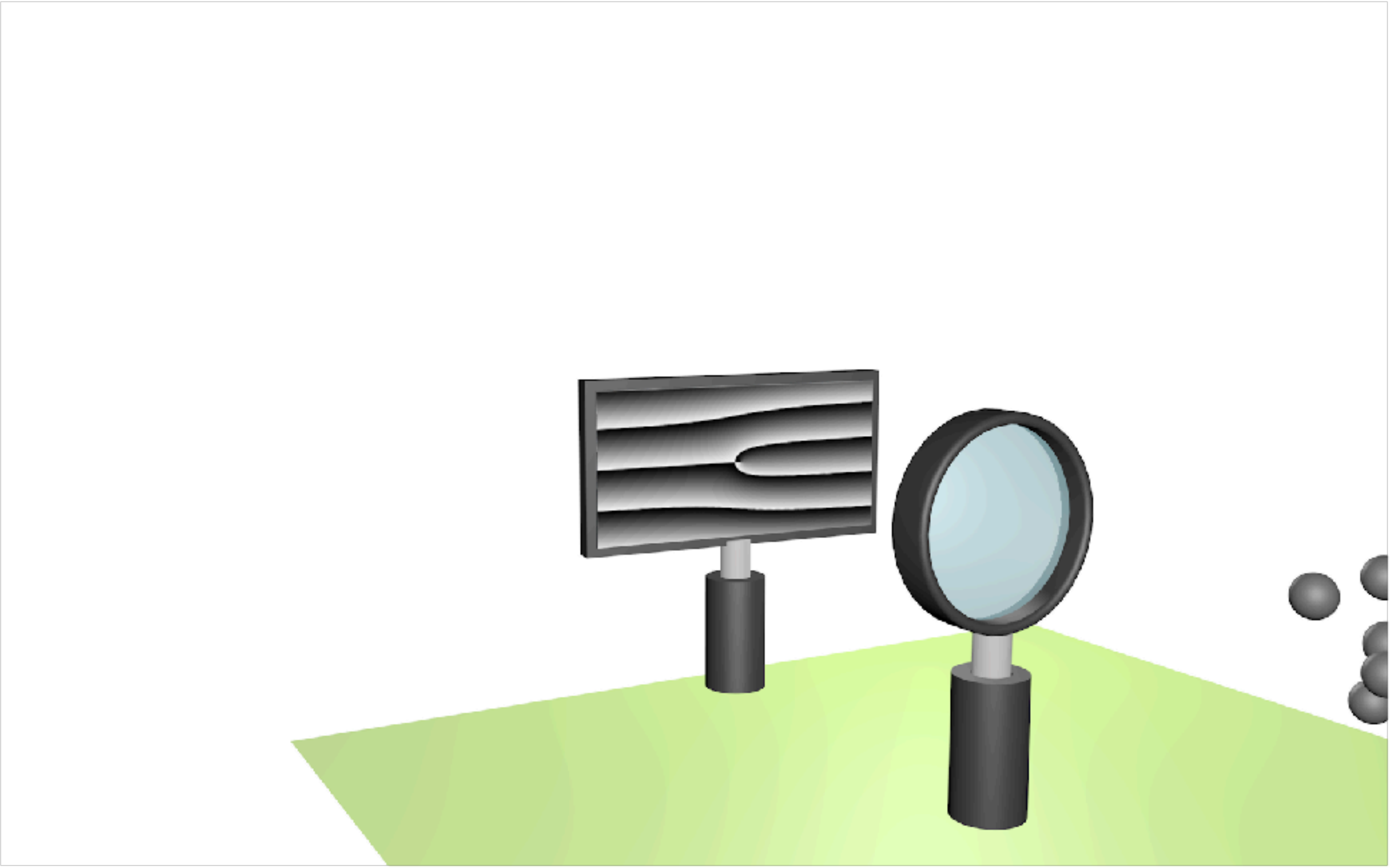


4. RECOVERING BEAM PROFILES

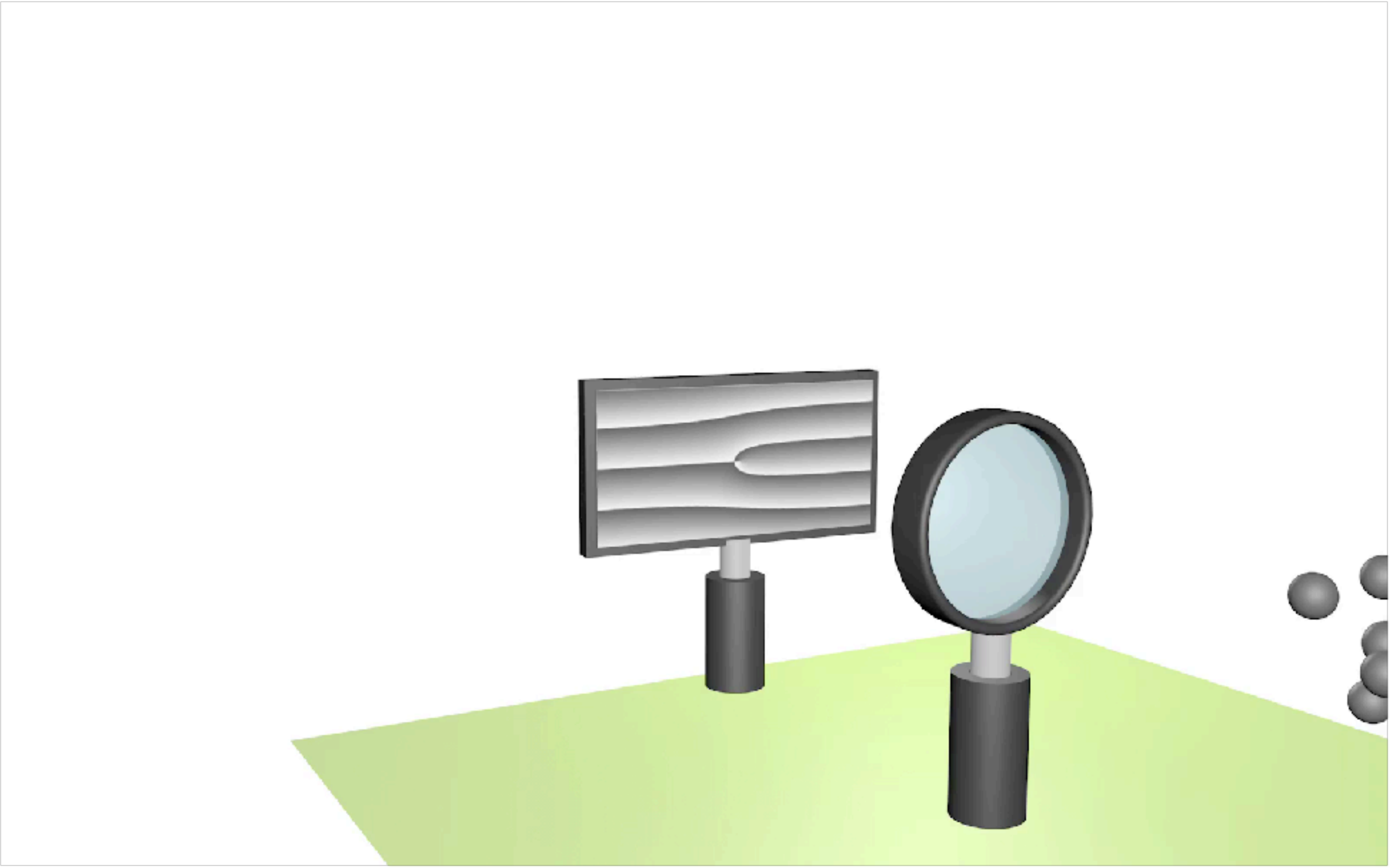


Harmonic 13

5. MEASURING OAM



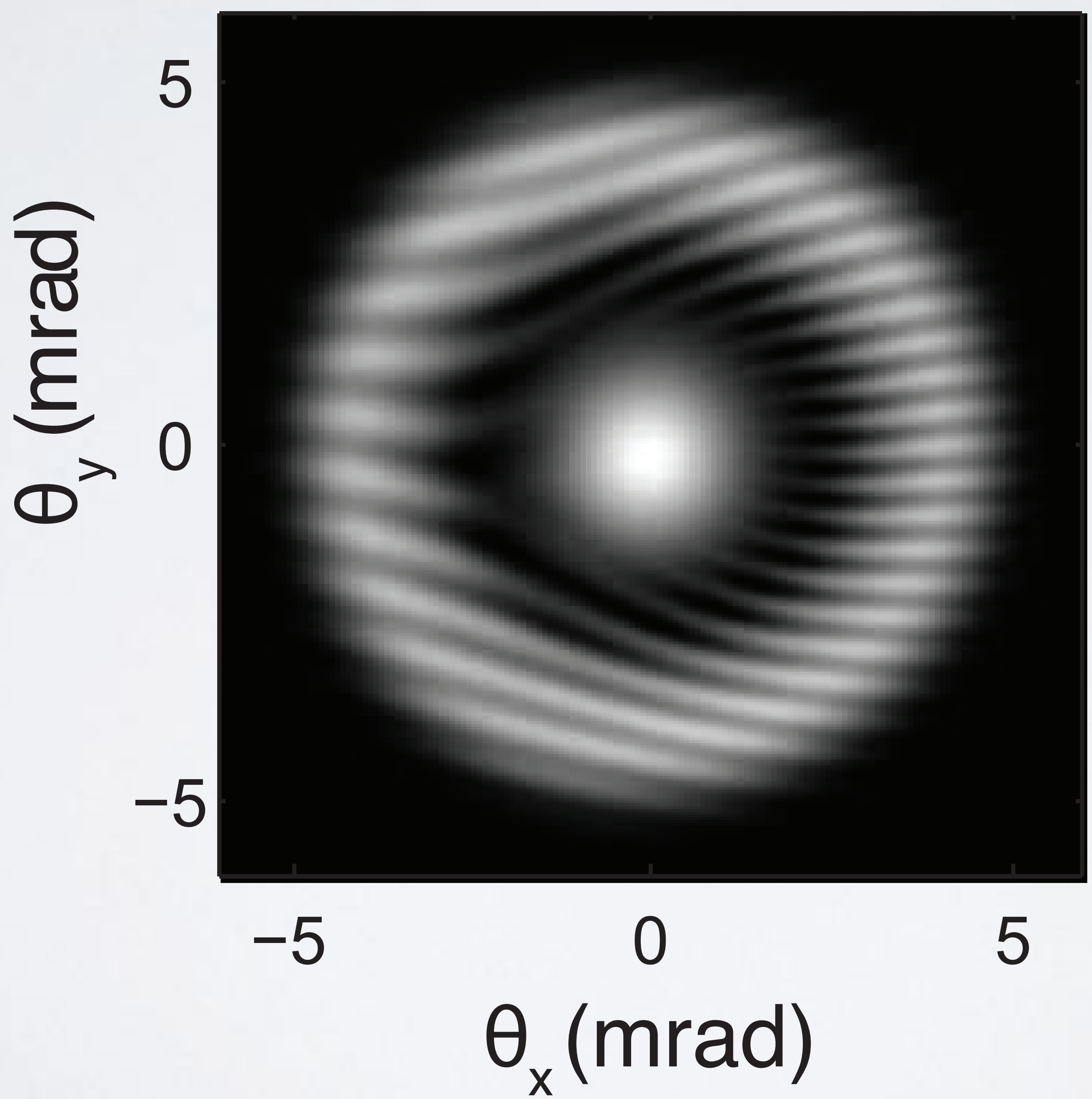
5. MEASURING OAM



5. MEASURING OAM

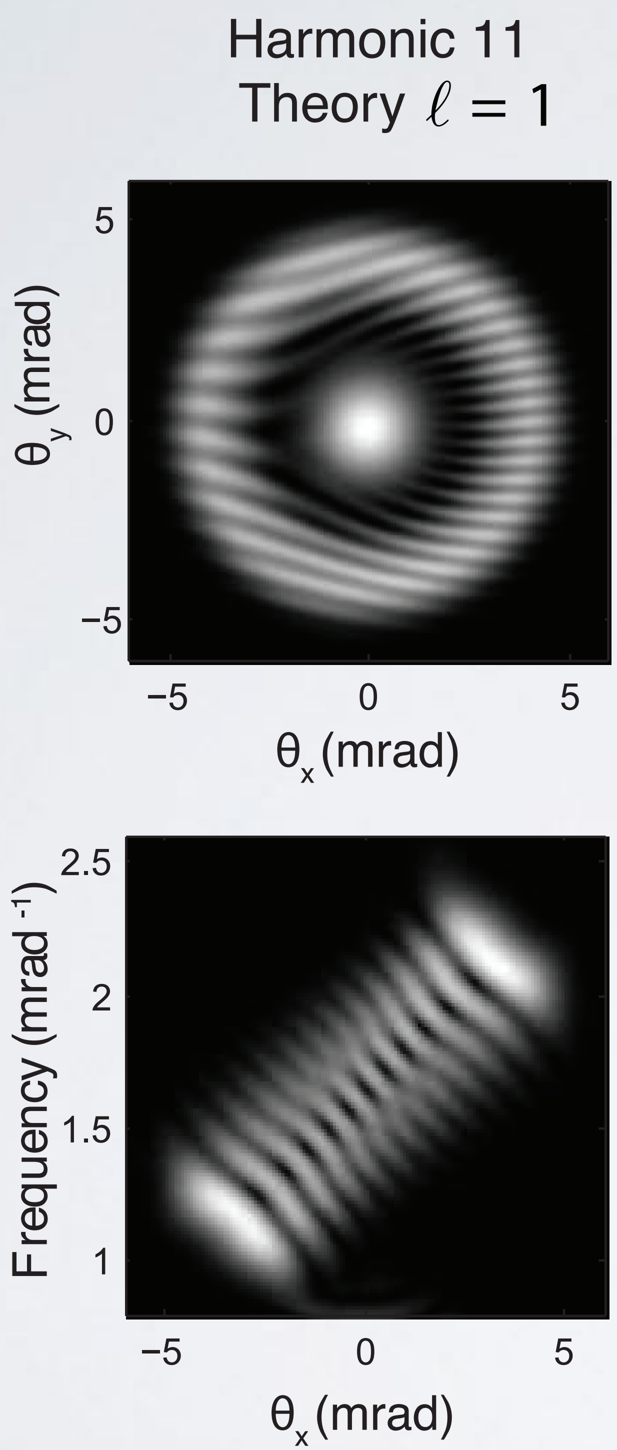
Harmonic 11

Theory $\ell = 1$



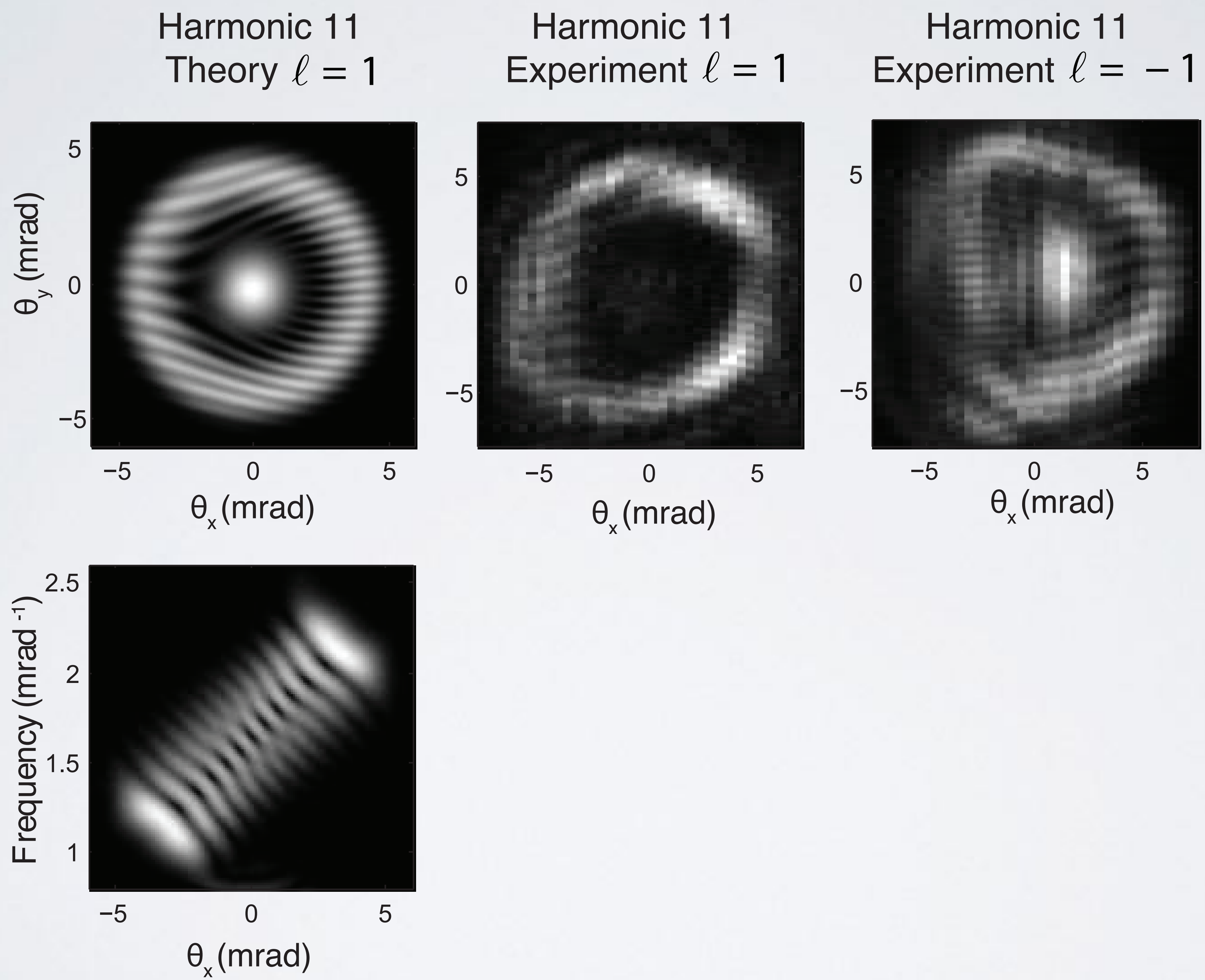
5. MEASURING OAM

Vertical Fourier Transform



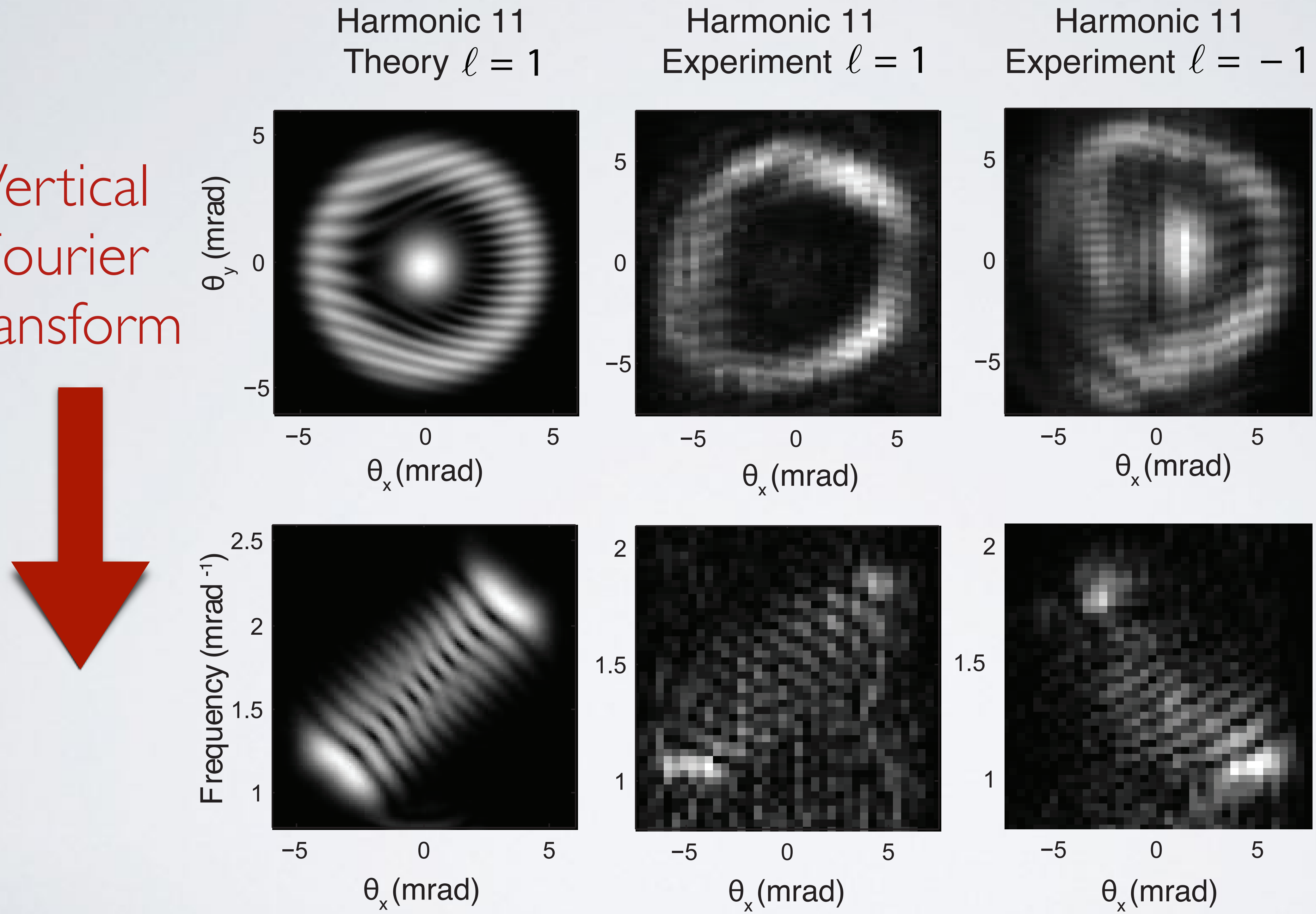
5. MEASURING OAM

Vertical Fourier Transform



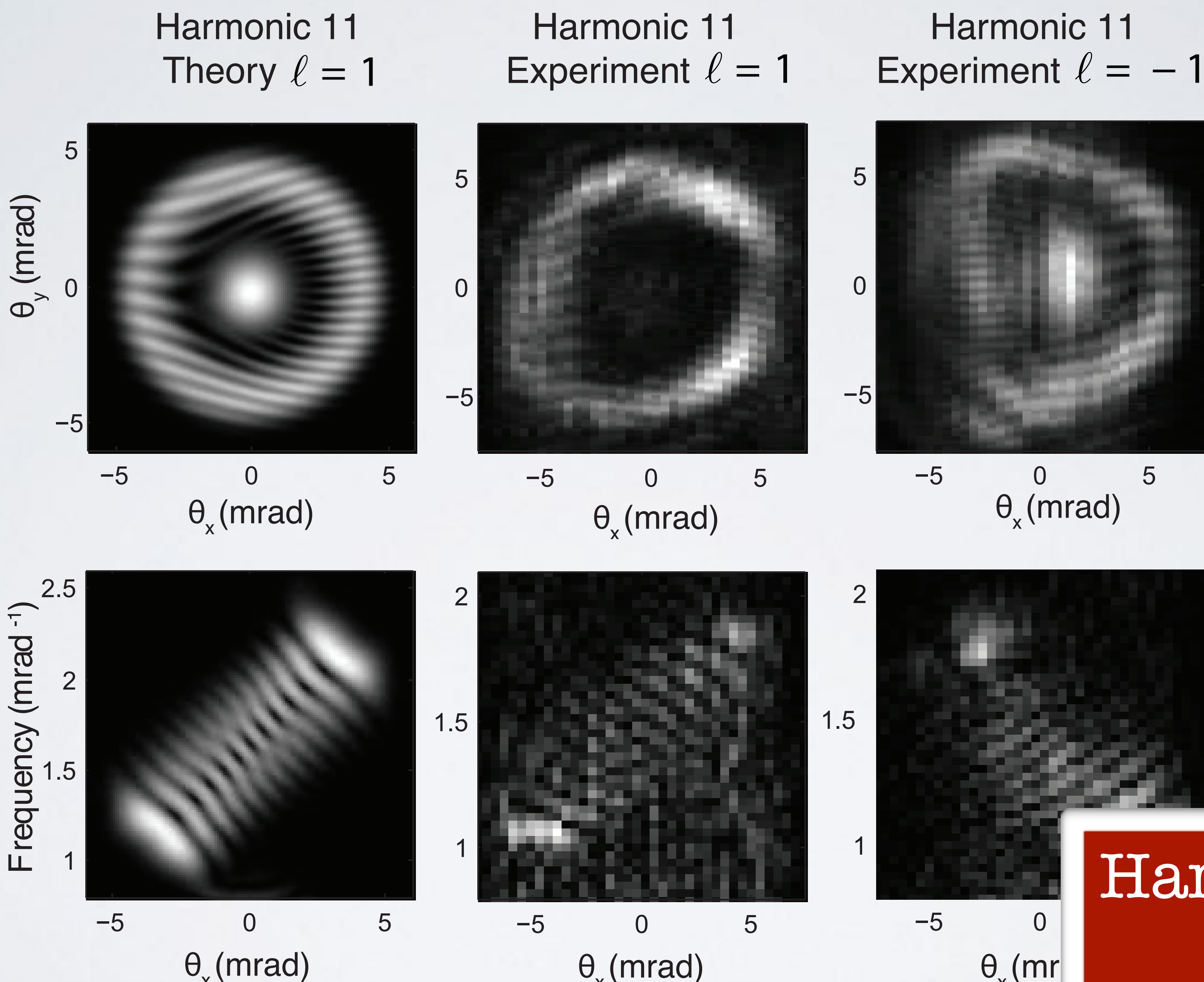
5. MEASURING OAM

Vertical Fourier Transform



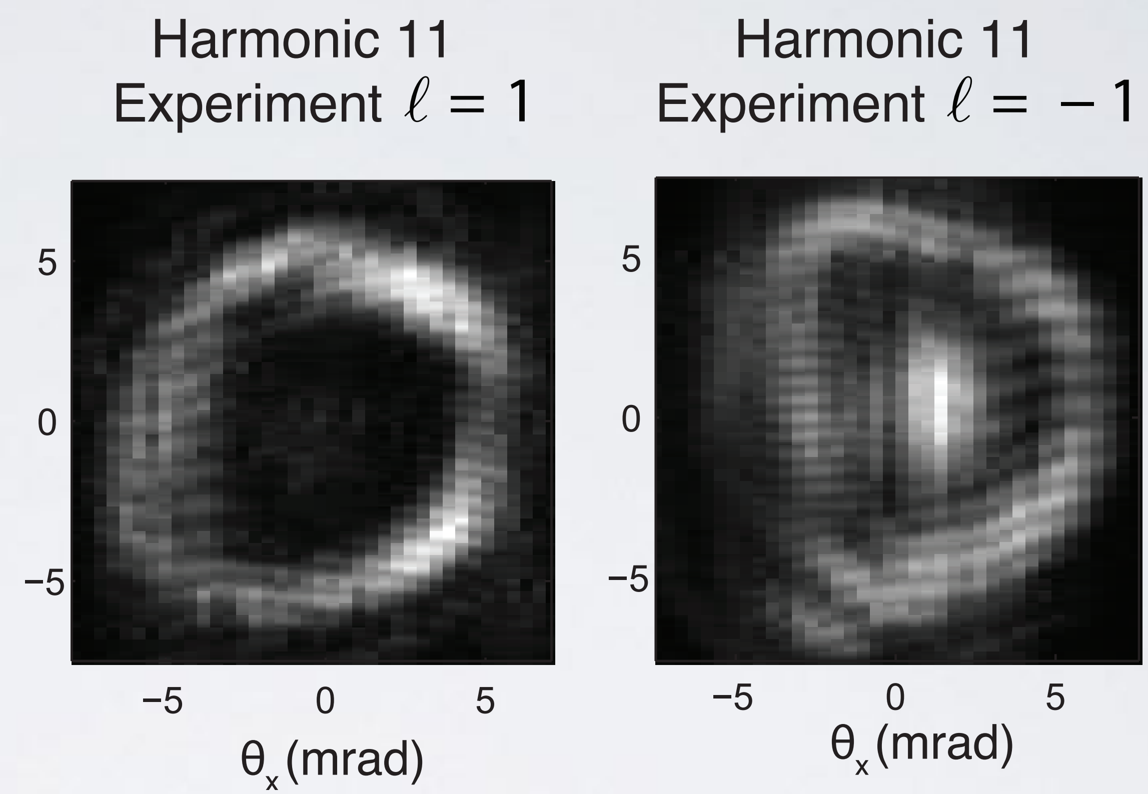
5. MEASURING OAM

Vertical
Fourier
Transform



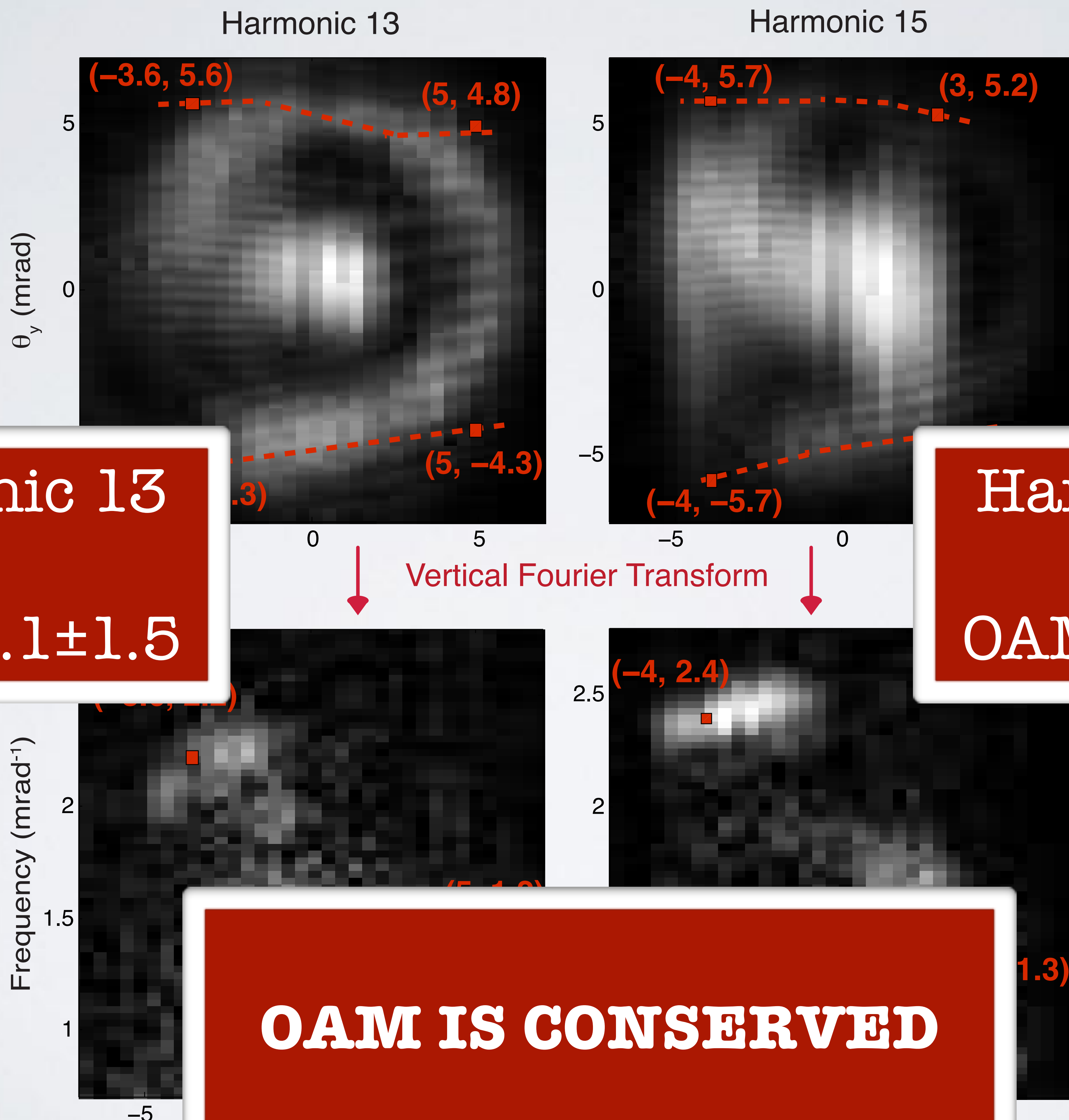
Harmonic 11
=
OAM 11

5. MEASURING OAM



Harmonic 11
=
OAM 11

5. MEASURING OAM



Harmonic 13 = OAM 13.1±1.5

Harmonic 15 = OAM 14.9±1.5

OAM IS CONSERVED

Comments:

1. What is importance of OAM of X-rays?

Applications include

- Superresolution imaging and machining with atomic-scale spatial resolution
- Secure communication with a high-frequency carrier

2. This work shows that OAM is conserved for a single, linearly polarized pump beam in the sense that

$$\ell(n^{\mathrm{th}}\ \mathrm{harmonic}) = n\ell(\mathrm{fundamental})$$

However, can we control / set the OAM value of the nth harmonic?

ARTICLE

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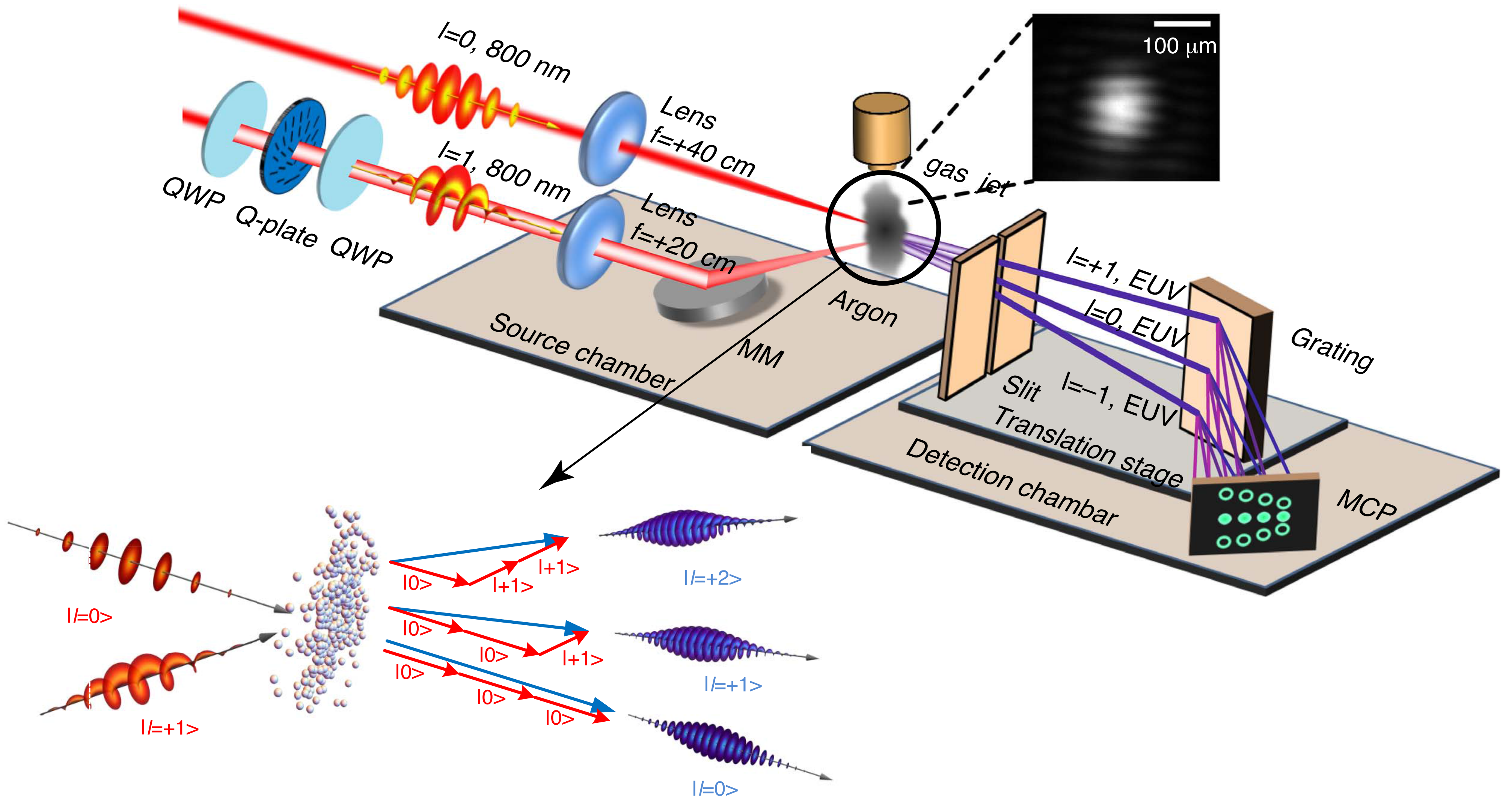
Controlling the orbital angular momentum of high harmonic vortices

Fanqi Kong[1,2], Chunmei Zhang[1,2], Frédéric Bouchard[1], Zhengyan Li[1,2], Graham G. Brown[1,2], Dong Hyuk Ko[1,2], T.J. Hammond[1,2], Ladan Arissian[2], Robert W. Boyd[1,3], Ebrahim Karimi[1] & P.B. Corkum[1,2]



Summary:

Best Wishes and Happy Birthday to Paul!