

Charles Townes: Creator of the Discipline of Photonics

Robert W. Boyd

(Part of the) Charles Townes Legacy

Inventor of the Laser

Discoverer of Fundamental Nonlinear Optical Processes

Autler-Townes Effect

Self Trapping of Light (Optical Solitons)

Stimulated Brillouin Scattering (SBS)

Also, his research group discovered light-by-light scattering
(the essence of photonics)

Presented at The Charles H. Townes Centennial Celebration Symposium, University of California at Berkeley, August 1 and 2, 2015.



What is Photonics?

And how is it different from optics?

Answer 1:

Optics is old name

Photonics is new name

Answer 2:

“Optics” has always been a misnomer.

Optos is Greek for vision.

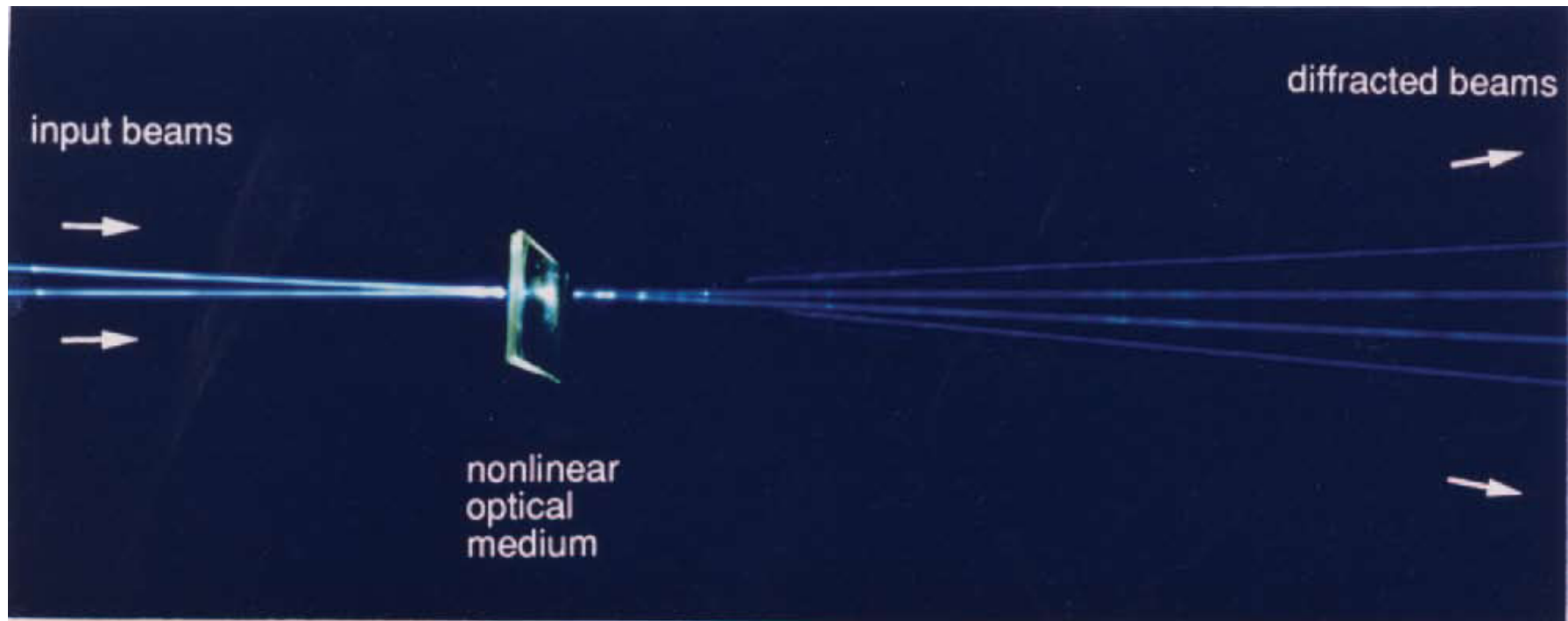
Photos is Greek for light.

Answer 3:

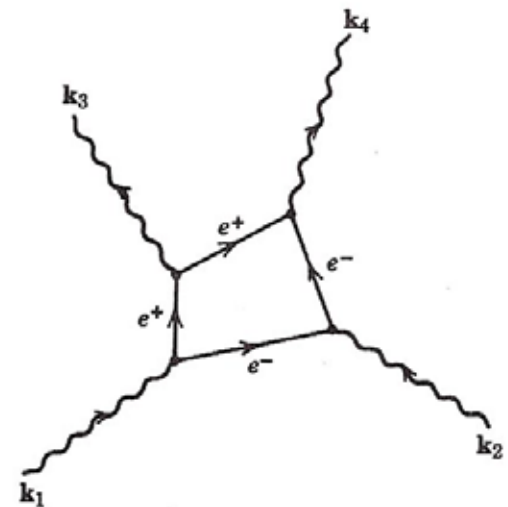
Photonics is doing useful things with light.

(As in the distinction between electronics and electricity.)

Essence of Photonics: Light-by-Light Scattering



The elementary process of light-by-light scattering has never been observed in vacuum, but is readily observed using the nonlinear response of material systems.



See also Carman, Chiao, and Kelley, Phys. Rev. Lett. 17, 1282 (1966).

Photonics is a US National Priority



Joe Biden announces that Rochester will host the Institute for Manufacturing Innovation in Integrated Photonics (a part of the National Photonics Institute), July 27, 2015.

Funding for five years to exceed \$600 Million.

Photonics has a huge commercial impact: a \$150 billion yearly market, world wide.



THE SCHAWLOW-TOWNES SYMPOSIUM ON PHOTONICS

THE SCHAWLOW-TOWNES SYMPOSIUM ON PHOTONICS IS NAMED IN HONOUR OF
CHARLES H. TOWNES AND THE LATE ARTHUR L. SCHAWLOW, PIONEERS IN LASER TECHNOLOGY.

For this inaugural event, the University of Ottawa is delighted to present
the following internationally acclaimed keynote speakers:



Erich Ippen

World-renowned expert in
femtosecond optics, Massachusetts
Institute of Technology



Gerd Leuchs

Director, Max Planck Institute for
the Science of Light, Germany



Charles H. Townes

Nobel laureate in physics for
his groundbreaking work in
quantum electronics

Friday, November 9, 2012

1 p.m. to 4 p.m.

Ottawa Convention Centre, Room 204
55 Colonel By Drive, Ottawa, Ontario

Also on that day: 9:30 a.m. to 12 p.m.

Presentations by **Olga Smirnova** (Max Born Institute, Berlin)

Albert Stolow (National Research Council of Canada)

Ksenia Dolgaleva (University of Toronto)

Jeff Lundeen (National Research Council of Canada)

Seating is limited.

Register online (free).

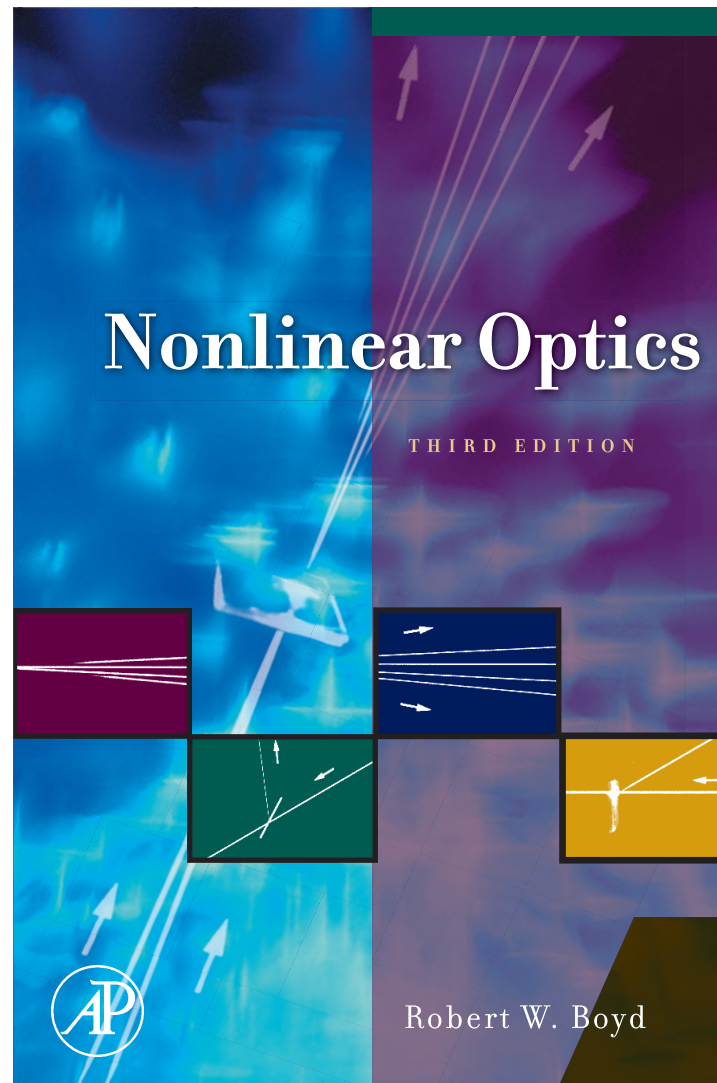
For more information:

judith.lachance@uottawa.ca



uOttawa

One of My Contributions to the Field of Photonics



First Edition 1992, Second Edition 2003, Third Edition 2008.

Some of My Research Projects

(But only the fun projects!)

Controlling the Velocity of Light

“Slow,” “Fast” and “Backwards” Light

– Light can be made to go:

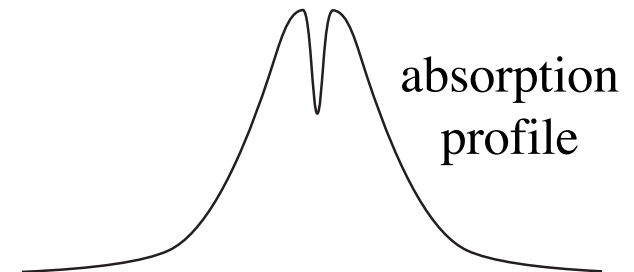
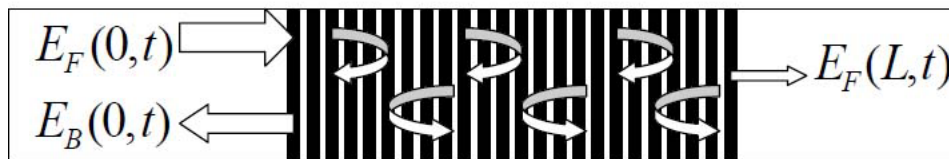
slow: $v_g \ll c$ (as much as 10^6 times slower!)

fast: $v_g > c$

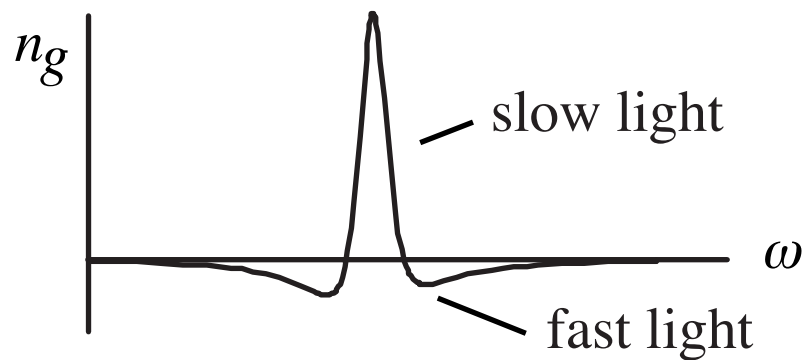
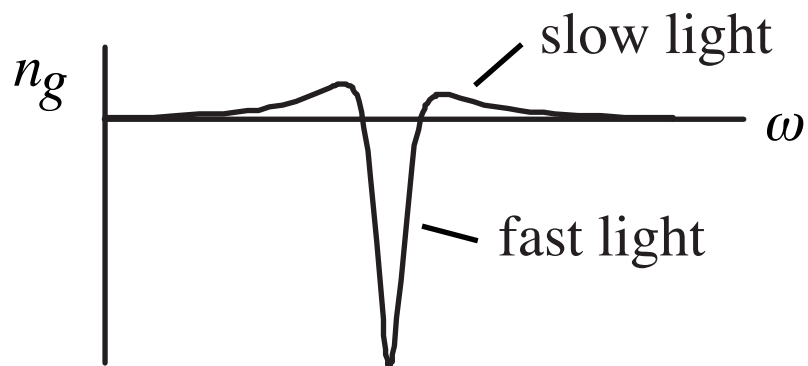
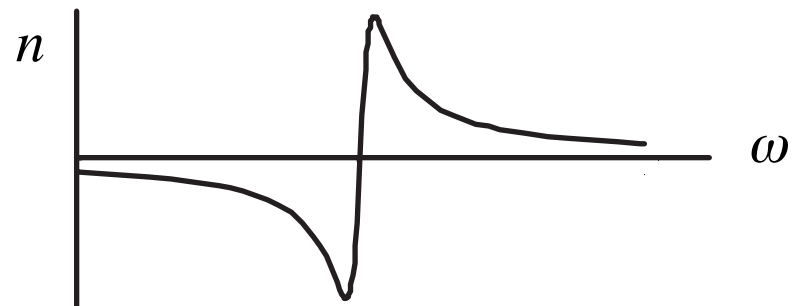
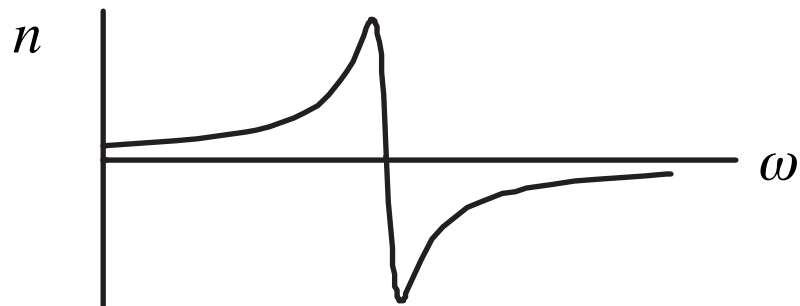
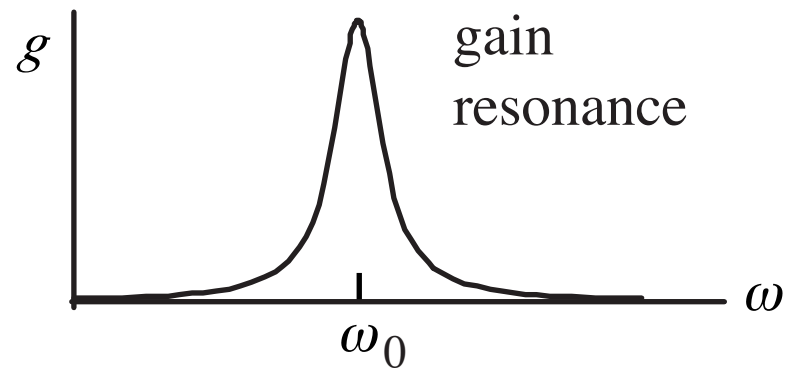
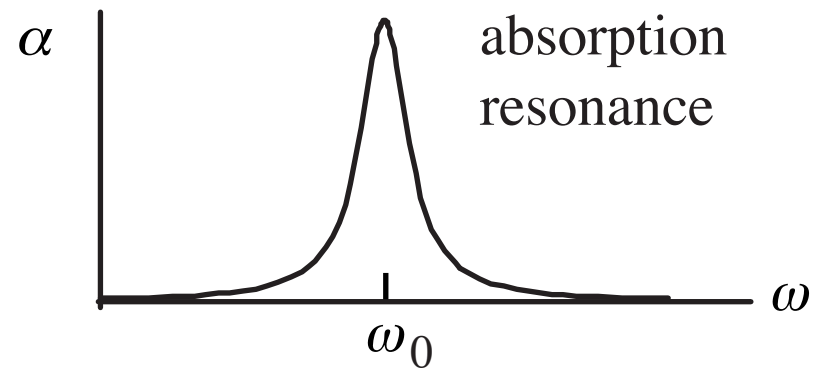
backwards: v_g negative

Here v_g is the group velocity: $v_g = c/n_g$ $n_g = n + \omega (dn/d\omega)$

– Velocity controlled by structural or material resonances



How to Control the Group Velocity of Light



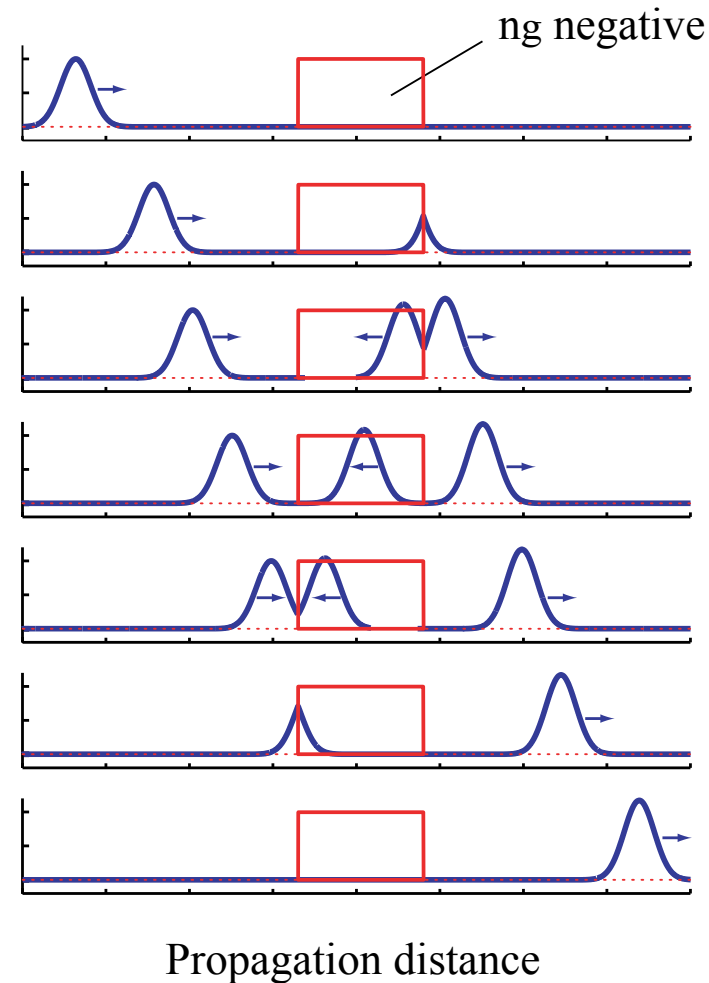
$$n_g = n + \omega (dn/d\omega)$$

Observation of Superluminal and “Backwards” Pulse Propagation

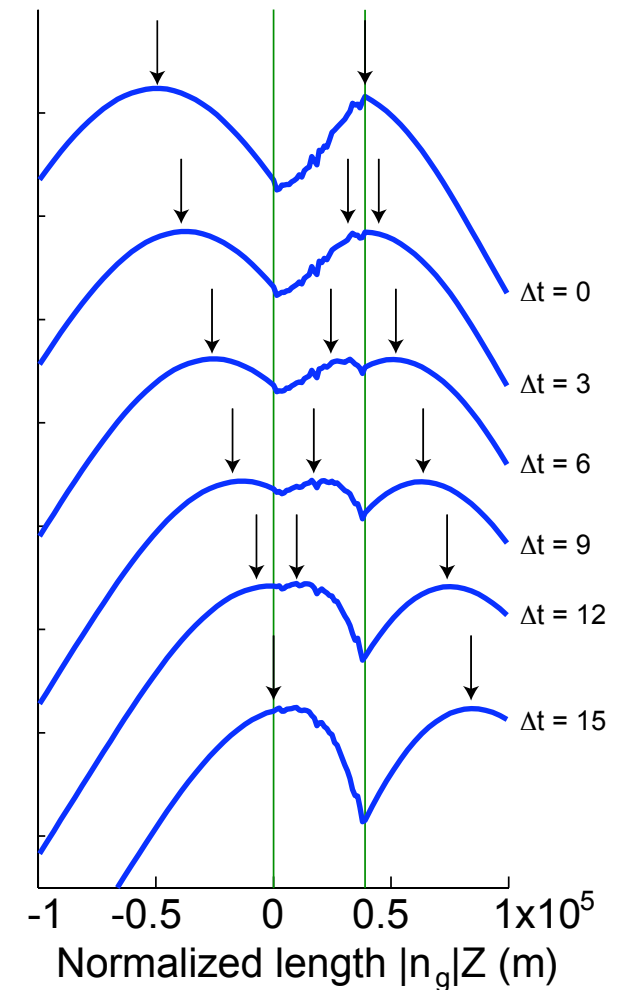


- A strongly counterintuitive phenomenon
- But entirely consistent with established physics
- Predicted by Garrett and McCumber (1970) and Chiao (1993).
- Observed by Gehring, Schweinsberg, Barsi, Kostinski, and Boyd Science 312, 985 2006.

- conceptual prediction



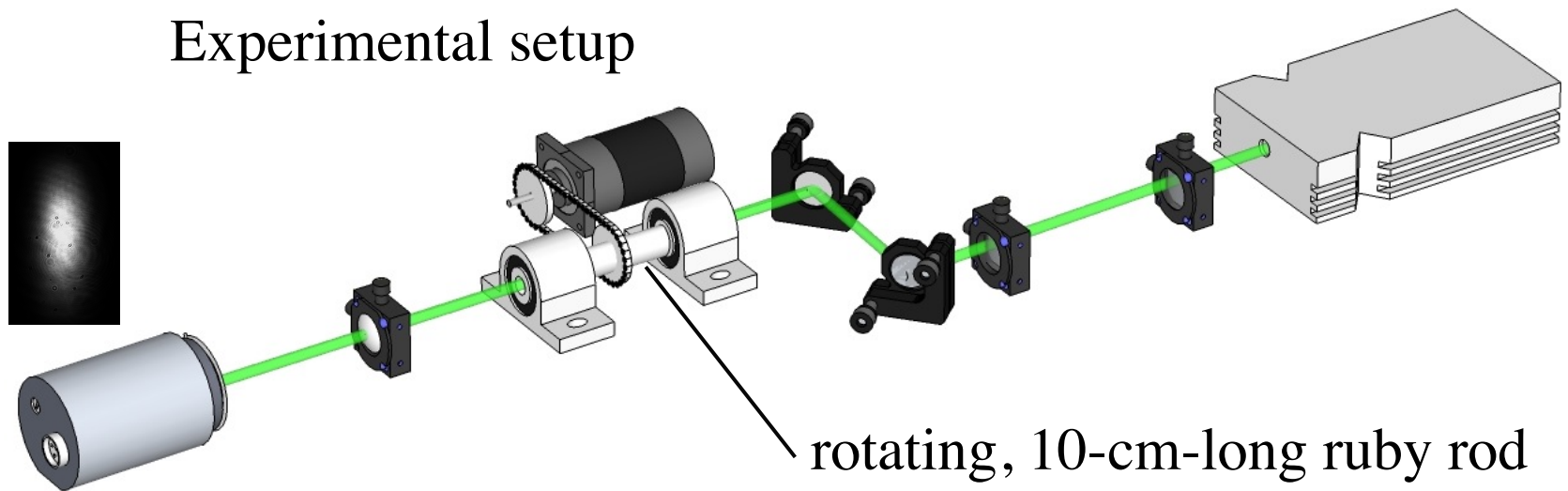
- laboratory results



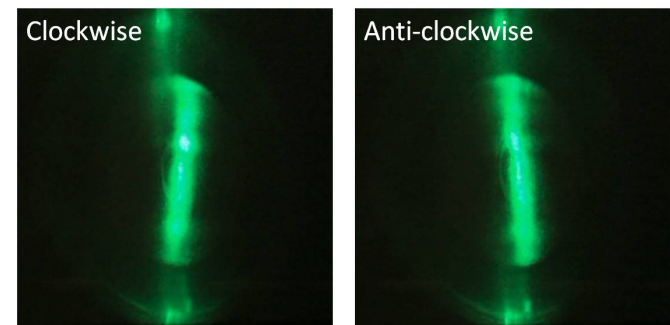
Observation of Rotary Photon Drag

The world as seen through a spinning window.
(Laser-excited ruby has a group index of 10^6 .)

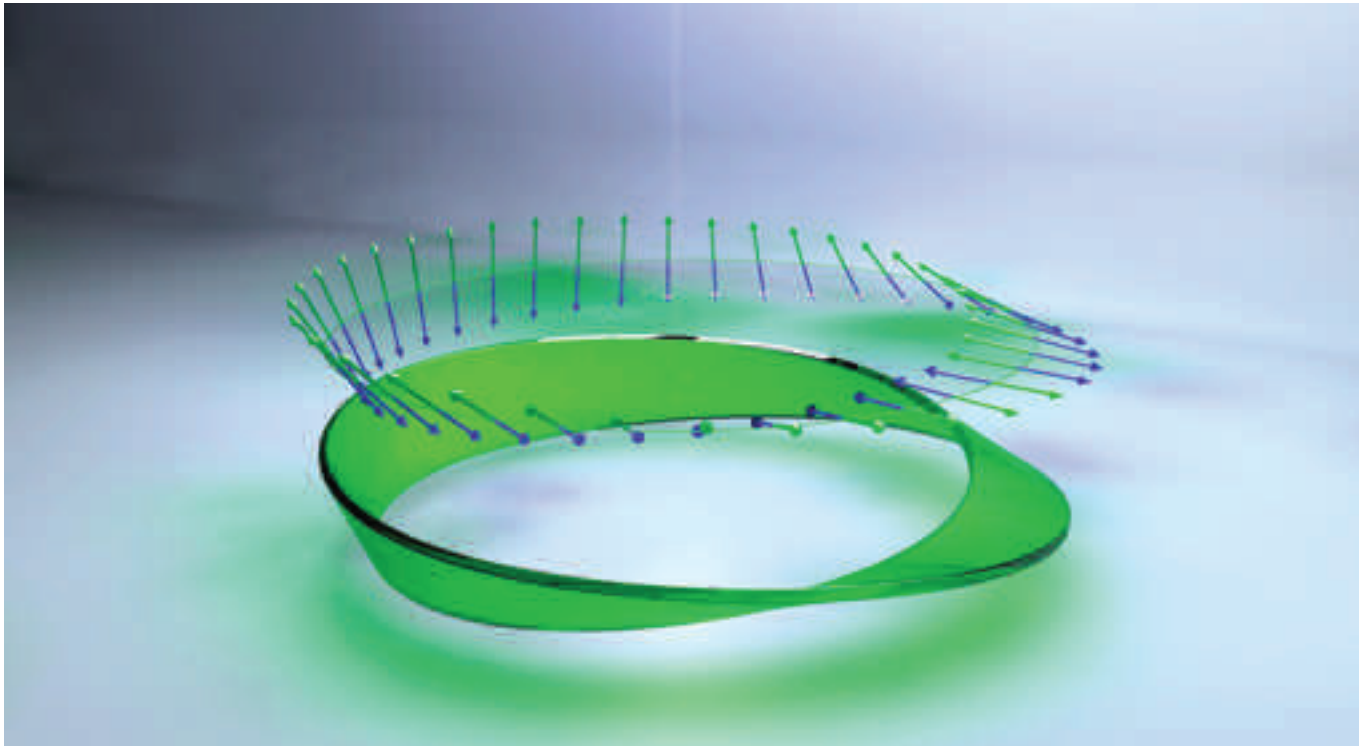
Experimental setup



Effect clearly visible by eye!



Observation of Optical Polarization Möbius Strips



Möbius strips are familiar geometrical structures, but their occurrence in nature is extremely rare. We generate such structures in the nanoscale in tightly focused vector light beams and confirm experimentally their Möbius topology. This work demonstrates that focused optical fields can possess complex structure at sub-wavelength distances and that advances in nano-optics provide the tools to probe these features.

Townes and Portraits



Charles H. Townes

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