Kolloquium gemeinsam mit dem SFB1277

Kolloquium

Prof. Dr. A. Douglas Stone
Dept of Applied Physics
Yale University, New Haven, USA

# Time-reversing a laser: What it means and why it's useful

physikalisches

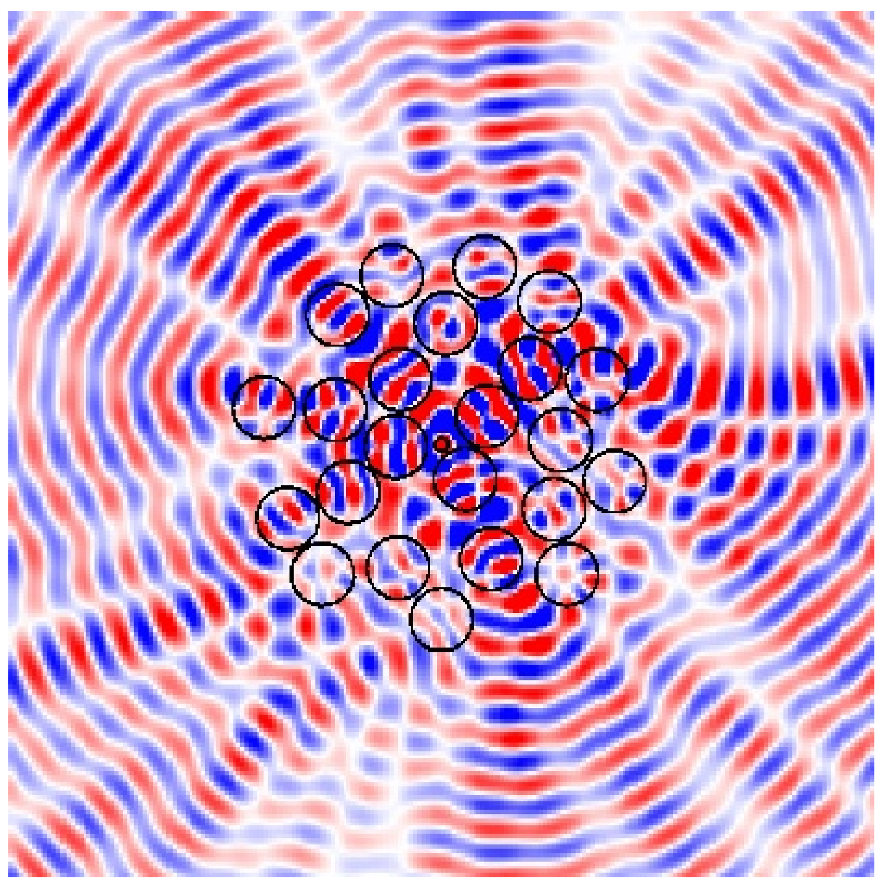
Mo. 15.5.23
16:00 Uhr
Ort: H34

Over a decade ago an overlooked symmetry of Maxwell's equations coupled to matter was recognized, a relationship between a laser at threshold and a perfectly absorbing resonator. The threshold condition for lasing is the point at which gain balances loss, and the system self-organizes to oscillate coherently at a specific frequency in the highest Q electromagnetic mode.

At this special point the system supports a purely outgoing solution of the Maxwell wave equation at a real frequency but with negligible amplitude, heralding the turn-on of a steady-state source of coherent radiation. Time-reversing this threshold lasing equation maps the laser system to another physical realizable Maxwell problem, one in which the time-reflected lasing mode is incident on an identical resonator, except that absorption loss replaces gain. This mapping implies that under very general conditions, any complex structure can be made to absorb perfectly at a specific frequency, if a specific *adapted* input wavefront is imposed and the loss is appropriately tuned, a phenomenon referred to as Coherent Perfect Absorption (CPA).

In the following years this effect has been demonstrated in a wide variety of electromagnetic platforms, as well as in acoustic and other wave systems. One dramatic discovery was that a cavity which has both gain and loss, perfectly balanced, can *simultaneously* lase in one mode and perfectly absorb a different mode.

Recently we have proposed a generalization of CPA, beyond perfect absorption, to a general theory of *reflectionless* excitation of arbitrary structures which support resonances for any kind of linear wave. Important applications of the generalized theory of CPA have been demonstrated to secure message transmission, analog computing, and signal routing. I will present the basic concepts of CPA and its generalizations in this talk, and review some of the proposed applications.



Time-reversal of a random laser

Fakultät für Physik