Non-Hermitian Physics Online
ICTS

Soliton Steering in Parity-Time Symmetric Nonlinear Couplers

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Date: March 23 , 2021

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Indian
Institute
of
Technology
Guwahati

My Research Group at IIT Guwahati

Current Members

Dipti

Abdelsalam

Sampreet

Roson

Dr. J.P. Deka

Dr. S. Chakraborty

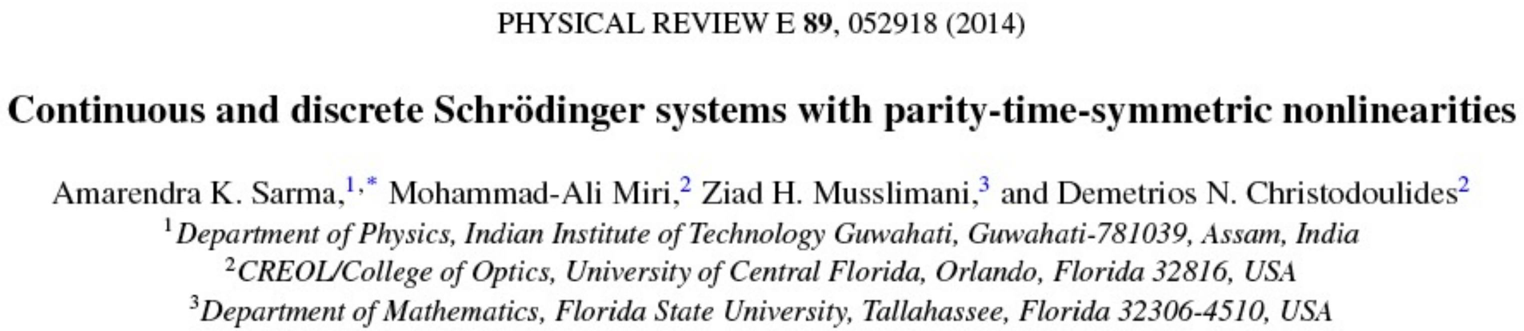
Dr. Ambaresh Sahoo

Our Research Interests

Quantum Optics
Nonlinear Optics
PT-Physics
Quantum Optomechanics
Soliton Physics

Our Recent Contributions to PT-Physics

I sincerely thank Prof. Demetrios Christodoulides for introducing this area to me!


PHYSICAL REVIEW E **89**, 052918 (2014)

Continuous and discrete Schrödinger systems with parity-time-symmetric nonlinearities

Amarendra K. Sarma,[1,*] Mohammad-Ali Miri,[2] Ziad H. Musslimani,[3] and Demetrios N. Christodoulides[2]
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[3]*Department of Mathematics, Florida State University, Tallahassee, Florida 32306-4510, USA*

Research Article | Vol. 57, No. 5 / 10 February 2018 / *Applied Optics* 1119

applied optics

Highly amplified light transmission in a parity-time symmetric multilayered structure

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Department of Physics, Indian Institute of Technology Guwahati, Guwahati, Assam 781039, India
**Corresponding author: aksarma@iitg.ernet.in*

PHYSICAL REVIEW A **100**, 063846 (2019)

Delayed sudden death of entanglement at exceptional points

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Department of Physics, Indian Institute of Technology Guwahati, Guwahati 781039, Assam, India

(Received 2 June 2019; published 27 December 2019)

Nonlinear Dyn (2019) 96:565–571
https://doi.org/10.1007/s11071-019-04806-z

ORIGINAL PAPER

Chaotic dynamics and optical power saturation in parity–time (*PT*) symmetric double-ring resonator

Jyoti Prasad Deka · Amarendra K. Sarma

Nonlinear Dyn
https://doi.org/10.1007/s11071-020-05585-8

ORIGINAL PAPER

Multifaceted nonlinear dynamics in $\mathcal{PT}$-symmetric coupled Liénard oscillators

Jyoti Prasad Deka · Amarendra K. Sarma · A. Govindarajan · Manas Kulkarni

Letter Vol. 44, No. 3 / 1 February 2019 / *Optics Letters* 663

Optics Letters

Tailoring $\mathcal{PT}$-symmetric soliton switch

A. Govindarajan,[1,*] Amarendra K. Sarma,[2] and M. Lakshmanan[1]

Research Article Vol. 37, No. 11 / November 2020 / *Journal of the Optical Society of America B* 3443

Journal of the Optical Society of America B

OPTICAL PHYSICS

Dark soliton steering in $\mathcal{PT}$-symmetric couplers with third-order and intermodal dispersions

Dipti Kanika Mahato,[1,*] A. Govindarajan,[2] and Amarendra K. Sarma[1]

AVS Quantum Science REVIEW scitation.org/journal/aqs

Continuous variable quantum entanglement in optomechanical systems: A short review

Cite as: AVS Quantum Sci. **3**, 015901 (2021); doi: 10.1116/5.0022349
Submitted: 20 July 2020 · Accepted: 20 November 2020 ·
Published Online: 6 January 2021

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Amarendra K. Sarma,[a)] Subhadeep Chakraborty,[b)] and Sampreet Kalita[c)]

Present Talk: Collaborators

Prof. M. Lakshmanan

Dr. A. Govindarajan

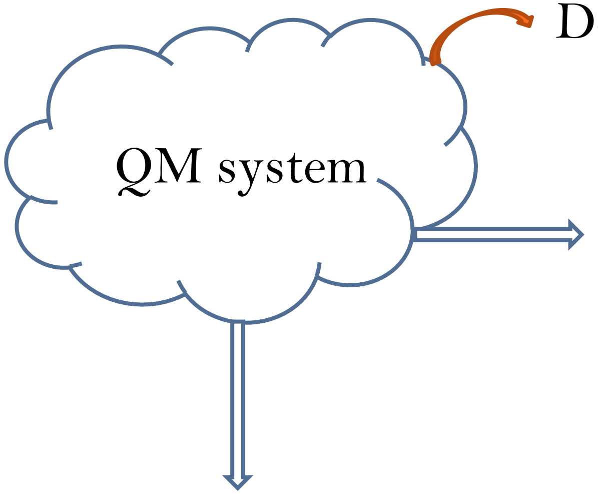
Dipti K. Mahato

Dr. Ambaresh Sahoo

Outline

- PT-symmetry in coupled waveguide system in Optics
- Nonlinear Coupler
- Soliton Steering in Nonlinear Coupler
- Troubles with Conventional Nonlinear Coupler
- Non-Hermitian Physics may be the saviour!
- Soliton Steering in Nonlinear Coupler
- Ultrashort pulse steering dynamics in PT-coupler with Kerr-nonlinearity
- Short pulse steering dynamics in PT-coupler with Saturating nonlinearity
- Conclusions

Basics of QM



Described by Hamiltonian H

Otherwise, energy eigenvalues are Complex.
H is Non-Hermitian: $H \neq H^{\dagger}$.

If Energy is experimentally measurable, energy eigenvalues of the system are Real.
H is assumed to be Hermitian: $H = H^{\dagger}$.

- Even a Non-Hermitian Hamiltonian can exhibit REAL eigenvalue, if H is PT-symmetric!

PT-Symmetry in Quantum Mechanics

VOLUME 80, NUMBER 24 PHYSICAL REVIEW LETTERS 15 JUNE 1998

Real Spectra in Non-Hermitian Hamiltonians Having $\mathcal{PT}$ Symmetry

Carl M. Bender[1] and Stefan Boettcher[2,3]
[1]*Department of Physics, Washington University, St. Louis, Missouri 63130*
[2]*Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545*
[3]*CTSPS, Clark Atlanta University, Atlanta, Georgia 30314*
(Received 1 December 1997; revised manuscript received 9 April 1998)

The condition of self-adjointness ensures that the eigenvalues of a Hamiltonian are real and bounded below. Replacing this condition by the weaker condition of $\mathcal{PT}$ symmetry, one obtains new infinite classes of complex Hamiltonians whose spectra are also real and positive. These $\mathcal{PT}$ symmetric theories may be viewed as analytic continuations of conventional theories from real to complex phase space. This paper describes the unusual classical and quantum properties of these theories. [S0031-9007(98)06371-6]

PACS numbers: 03.65.Ge, 02.60.Lj, 11.30.Er

PT SYMMETRY IN QUANTUM PHYSICS: FROM A MATHEMATICAL CURIOSITY TO OPTICAL EXPERIMENTS

LETTERS
PUBLISHED ONLINE: 24 JANUARY 2010 | DOI: 10.1038/NPHYS1515
nature physics

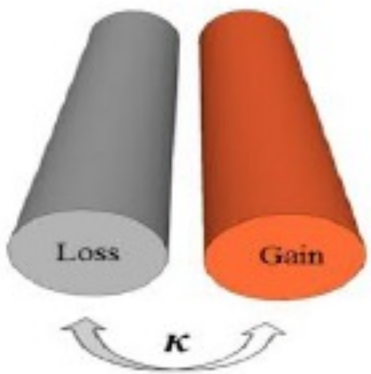
Observation of parity–time symmetry in optics

Christian E. Rüter[1], Konstantinos G. Makris[2], Ramy El-Ganainy[2], Demetrios N. Christodoulides[2], Mordechai Segev[3] and Detlef Kip[1]*

One of the fundamental axioms of quantum mechanics is associated with the Hermiticity of physical observables[1]. In the case of the Hamiltonian operator, this requirement not only implies real eigenenergies but also guarantees probability ($\varepsilon > \varepsilon_{th}$), the spectrum ceases to be real and starts to involve imaginary eigenvalues. This signifies the onset of a spontaneous *PT* symmetry-breaking, that is, a 'phase transition' from the exact to broken-*PT* phase[7,20].

QM	Optics
$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \psi}{\partial x^2} + V(x)\,\psi$ • PT-symmetric if $V(x) = V^*(-x)$	$i\frac{\partial E(x,z)}{\partial z} = \left[-\frac{1}{2k_0 n_0}\frac{\partial^2}{\partial x^2} + V(x)\right] E(x,z)$ • Optical Potential: $V(x) = k_0\big(n_R(x) + i n_I(x)\big)$ • PT-symmetric if $n_R(x) = n_R(-x)$ and $n_I(x) = -n_I(-x)$

COUPLED WAVEGUIDES



$$i\frac{da}{dt} - iga + \kappa b = 0, i\frac{db}{dt} + igb + \kappa a = 0$$

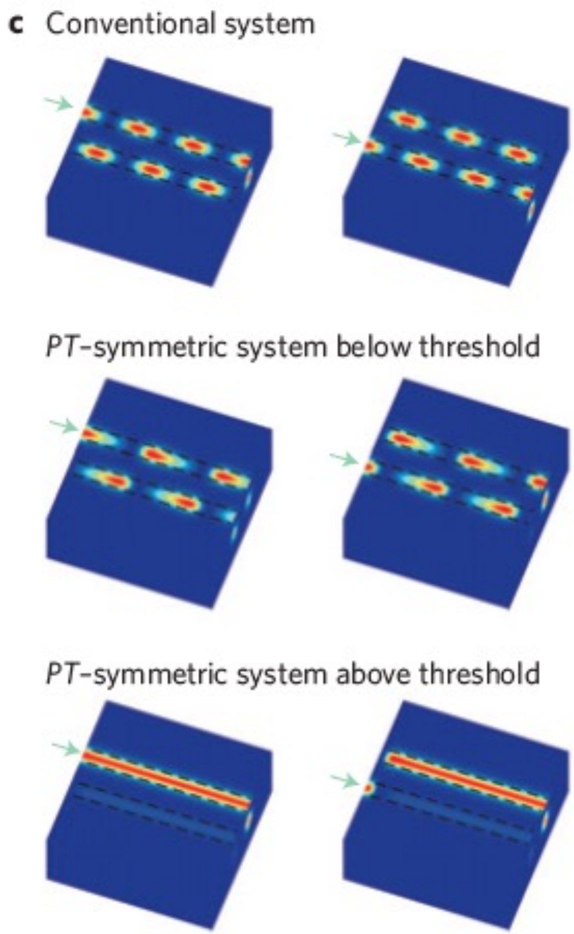
$$H = \begin{pmatrix} ig & -\kappa \\ -\kappa & -ig \end{pmatrix}$$

$$E = \sqrt{\kappa^2 - g^2}$$

$$|1\rangle_{belowEP} = \begin{pmatrix} 1 \\ e^{i\Theta} \end{pmatrix}, |2\rangle_{belowEP} = \begin{pmatrix} 1 \\ -e^{-i\Theta} \end{pmatrix} \qquad sin\Theta = g/\kappa$$

$$|1\rangle_{aboveEP} = \begin{pmatrix} 1 \\ ie^{\Theta} \end{pmatrix}, |2\rangle_{aboveEP} = \begin{pmatrix} 1 \\ ie^{-\Theta} \end{pmatrix} \qquad cosh\Theta = g/\kappa$$

Launch condition is important in PT Systems!



THE EXPERIMENT

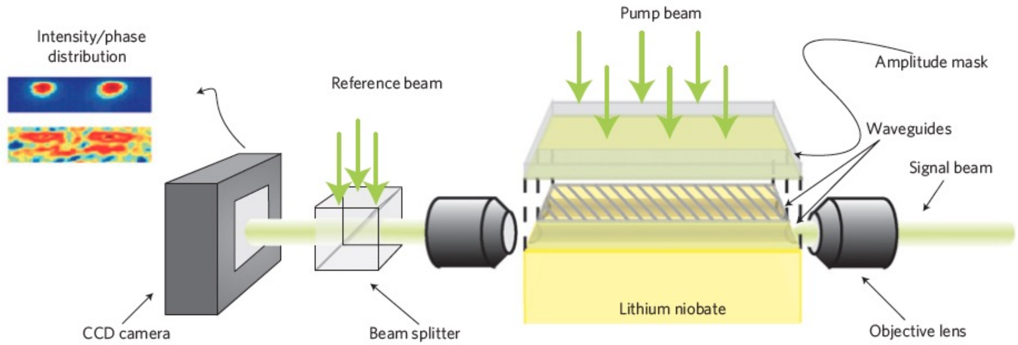
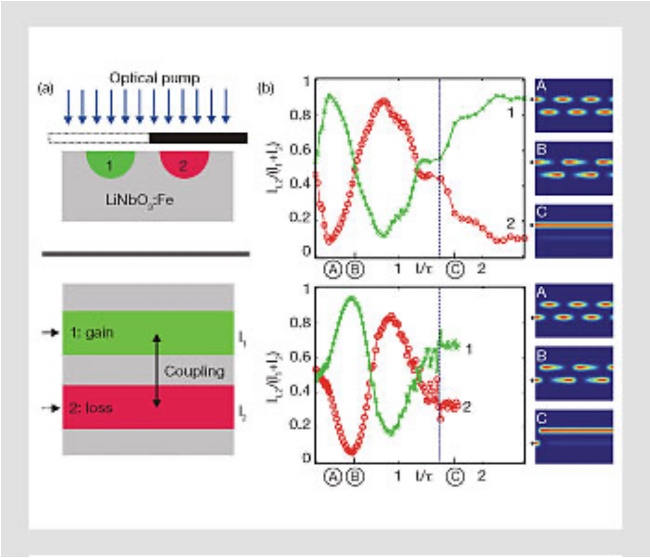
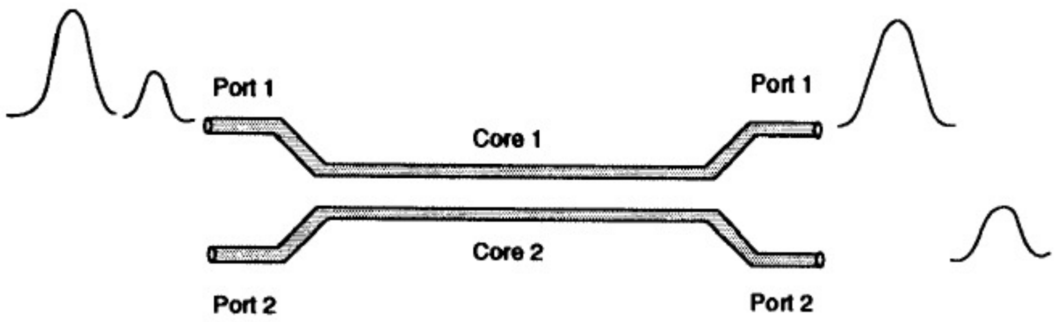


Figure 2 | Experimental set-up. An Ar^+ laser beam (wavelength 514.5 nm) is coupled into the arms of the structure fabricated on a photorefractive $LiNbO_3$ substrate. An amplitude mask blocks the pump beam from entering channel 2, thus enabling two-wave mixing gain only in channel 1. A CCD camera is used to monitor both the intensity and phases at the output.



(a) Front (top) and top (bottom) view of the PT-symmetric coupled system fabricated in $LiNbO_3$. (b) Measured (normalized) intensities $I_{1,2}$ at the output facet during optical pumping as a function of time t (normalized by the time constant τ for build-up of gain). The upper/lower panel shows the situation when light is coupled into channel 1 and 2, respectively. Clearly, with increasing gain, the system behaves in a nonreciprocal manner. Blue dashed lines mark the symmetry-breaking threshold. Above that, light is predominantly guided in channel 1—thus experiencing gain—and the intensity in both channels depends solely on the magnitude of the gain. The power evolution is also depicted (last column) at various times.

NONLINEAR COUPLER

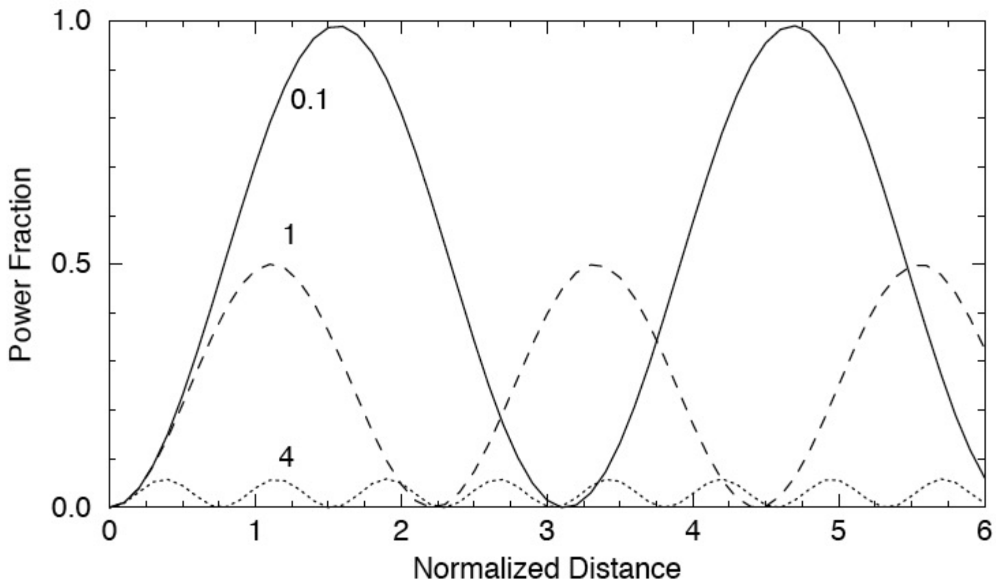


Input pulses appear at different output ports depending on their peak powers

$$\frac{\partial A_1}{\partial z} + \frac{1}{v_g}\frac{\partial A_1}{\partial t} + \frac{i\beta_2}{2}\frac{\partial^2 A_1}{\partial t^2} = i\kappa A_2 + i\gamma(|A_1|^2 + \sigma|A_2|^2)A_1$$

$$\frac{\partial A_2}{\partial z} + \frac{1}{v_g}\frac{\partial A_2}{\partial t} + \frac{i\beta_2}{2}\frac{\partial^2 A_2}{\partial t^2} = i\kappa A_1 + i\gamma(|A_2|^2 + \sigma|A_1|^2)A_2$$

Coupler: Low power optical beams (CW)



Fraction of power transferred to the second core plotted as a function of kz

$$\frac{dA_1}{dz} = i\kappa_{12}A_2 + i\delta_a A_1$$

$$\frac{dA_2}{dz} = i\kappa_{21}A_1 - i\delta_a A_2$$

$$P_1(L) = P_0 \cos^2(\kappa L)$$

$$P_2(L) = P_0 \sin^2(\kappa L)$$

Power transfer to the second core occurs in a periodic fashion. The maximum power is transferred at distances such that $\kappa_e z = m\pi/2$, where *m* is an integer. The shortest distance at which maximum power is transferred to the second core for the first time is called the *coupling length* and is given by $L_c = \pi/(2\kappa_e)$

Coupler: **Linear** Pulse Switching

$$\frac{\partial A_1}{\partial z} + \frac{i\beta_2}{2}\frac{\partial^2 A_1}{\partial T^2} = i\kappa A_2$$
$$\frac{\partial A_2}{\partial z} + \frac{i\beta_2}{2}\frac{\partial^2 A_2}{\partial T^2} = i\kappa A_1$$

For $L \ll L_D$ with $L_D = T_0^2/|\beta_2|$

$$\kappa(\omega) \approx \kappa_0 + (\omega - \omega_0)\kappa_1 + \tfrac{1}{2}(\omega - \omega_0)^2\kappa_2$$

$$A_1(z,T) = \tfrac{1}{2}\left[A_0(T - \kappa_1 z)e^{i\kappa_0 z} + A_0(T + \kappa_1 z)e^{-i\kappa_0 z}\right]$$
$$A_2(z,T) = \tfrac{1}{2}\left[A_0(T - \kappa_1 z)e^{i\kappa_0 z} - A_0(T + \kappa_1 z)e^{-i\kappa_0 z}\right]$$

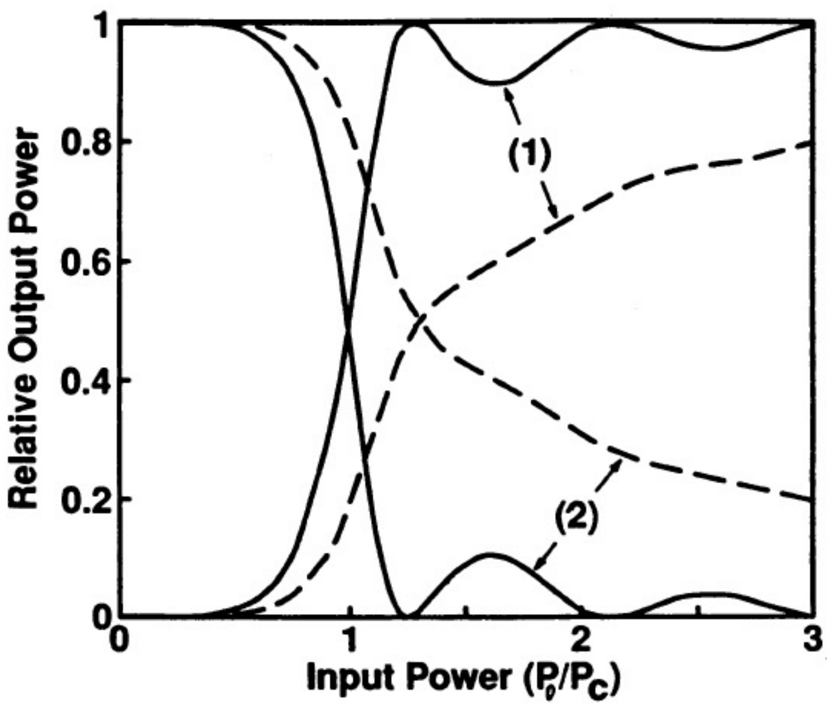
When $\kappa_1 = 0$

$$A_1(z,T) = A_0(T)\cos(\kappa_0 z), \qquad A_2(z,T) = A_0(T)\sin(\kappa_0 z)$$

Nonlinear Coupler: Quasi-CW Switching

$$\frac{dA_1}{dz} = i\kappa A_2 + i\gamma(|A_1|^2 + \sigma|A_2|^2)A_1$$

$$\frac{dA_2}{dz} = i\kappa A_1 + i\gamma(|A_2|^2 + \sigma|A_1|^2)A_2$$

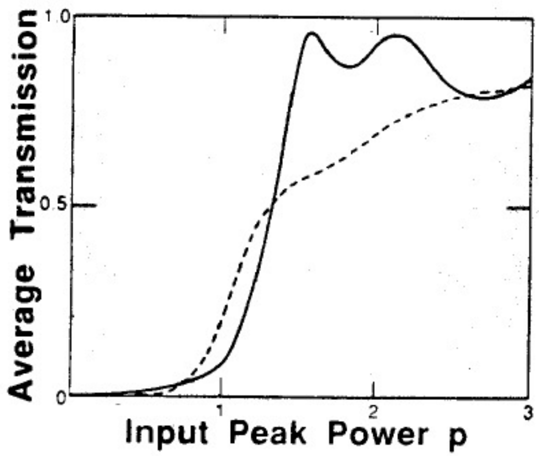


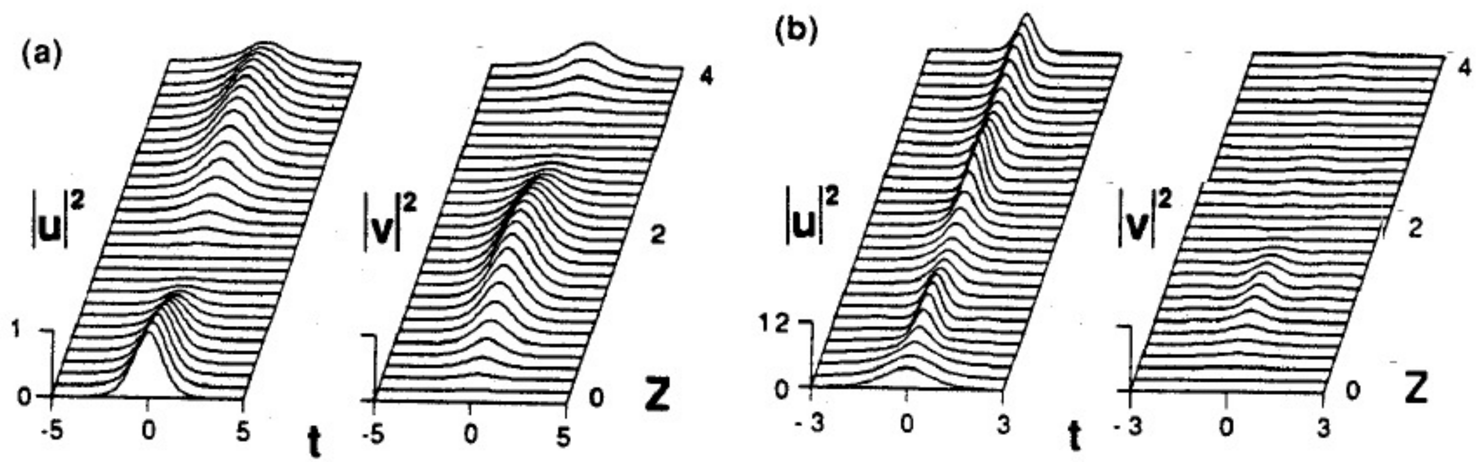
Nonlinear Coupler: Nonlinear Switching

$$i\frac{\partial u}{\partial \xi} - \frac{s}{2}\frac{\partial^2 u}{\partial \tau^2} + |u|^2 u + Kv = 0$$

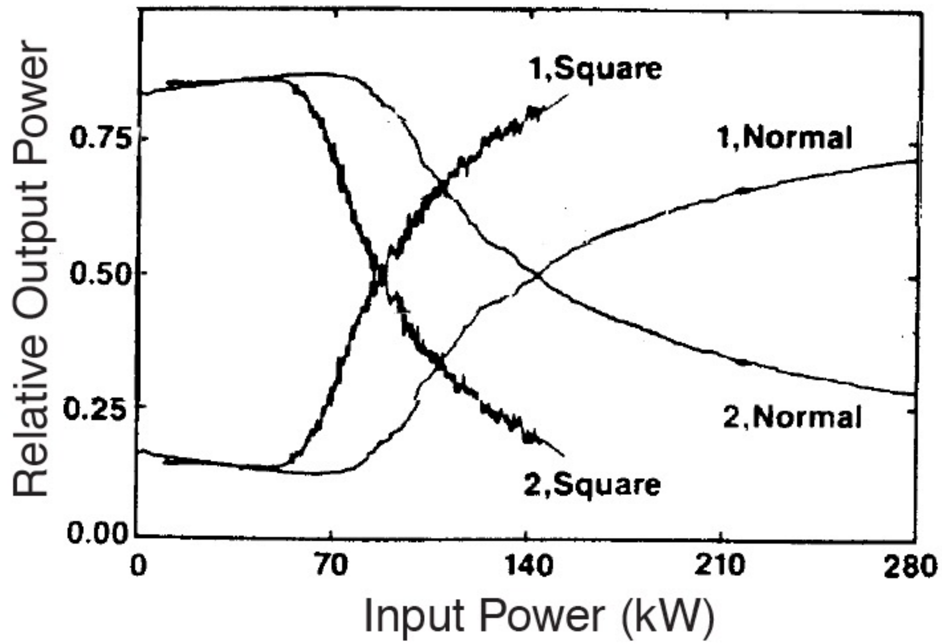
$$i\frac{\partial v}{\partial \xi} - \frac{s}{2}\frac{\partial^2 v}{\partial \tau^2} + |v|^2 v + Ku = 0$$

$$\xi = z/L_D, \quad \tau = T/T_0, \quad u = (\gamma L_D)^{1/2} A_1, \quad v = (\gamma L_D)^{1/2} A_2$$




(a)
|u|²
|v|²
1
0
-5
0
5
t
-5
0
5
4
2
0
Z
(b)
|u|²
|v|²
12
0
- 3
0
3
t
- 3
0
3
4
2
0
Z

Troubles with Conventional Nonlinear Coupler



Extremely High power levels are needed for nonlinear switching in Fiber Couplers

Non-Hermitian Physics may be the saviour!

Letter Vol. 44, No. 3 / 1 February 2019 / *Optics Letters* 663

Optics Letters

Tailoring $\mathcal{PT}$-symmetric soliton switch

A. Govindarajan,[1,*] Amarendra K. Sarma,[2] and M. Lakshmanan[1]

[1]Centre for Nonlinear Dynamics, School of Physics, Bharathidasan University, Tiruchirappalli-620 024, India
[2]Department of Physics, Indian Institute of Technology Guwahati, Guwahati, Assam-781039, India

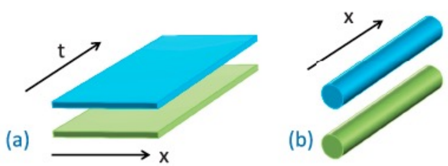
Different configurations of PT-symmetric coupler: (a) Type-1, (b) Type-2 coupler.

Some notable works on Nonlinear PT-Coupler

PHYSICAL REVIEW A **85**, 063837 (2012)

Optical solitons in $\mathcal{PT}$-symmetric nonlinear couplers with gain and loss

N. V. Alexeeva,[*] I. V. Barashenkov,[†] Andrey A. Sukhorukov, and Yuri S. Kivshar
Nonlinear Physics Centre, Australian National University, Canberra ACT 0200, Australia

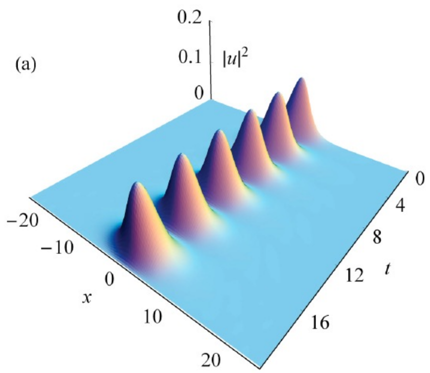


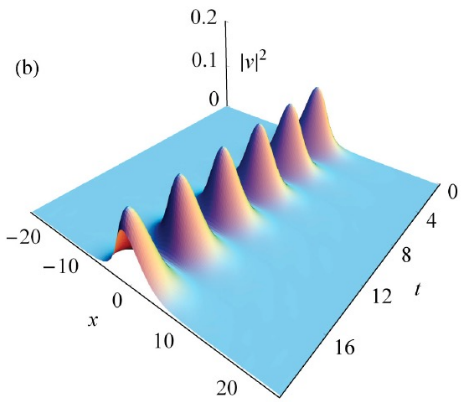
$$iu_t + u_{xx} + 2|u|^2 u = -v + i\gamma u$$
$$iv_t + v_{xx} + 2|v|^2 v = -u - i\gamma v.$$

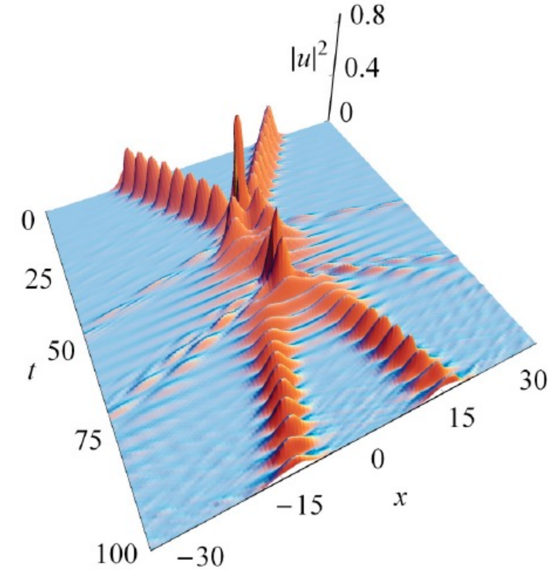
PHYSICAL REVIEW A **86**, 053809 (2012)

Breathers in $\mathcal{PT}$-symmetric optical couplers

I. V. Barashenkov,[1,2,3] Sergey V. Suchkov,[1,4] Andrey A. Sukhorukov,[1] Sergey V. Dmitriev,[4] and Yuri S. Kivshar[1]
[1]*Nonlinear Physics Centre, Research School of Physics and Engineering, Australian National University, Canberra, Australian Capital Territory 0200, Australia*
[2]*Department of Mathematics, University of Cape Town, Rondebosch 7701, South Africa*
[3]*Joint Institute for Nuclear Research, Dubna, Russia*
[4]*Institute for Metal Superplasticity Problems, Russian Academy of Sciences, Ufa 450001, Russia*







November 15, 2011 / Vol. 36, No. 22 / OPTICS LETTERS 4323

Stability of solitons in parity-time-symmetric couplers

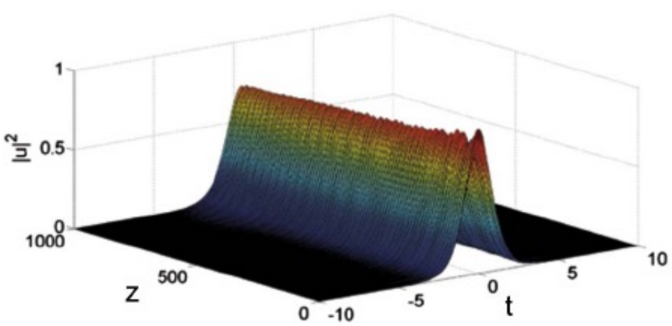
Rodislav Driben[1,2,*] and Boris A. Malomed[2]

[1]Jerusalem College of Engineering—Ramat Beit HaKerem, P.O. Box 3566, Jerusalem 91035, Israel

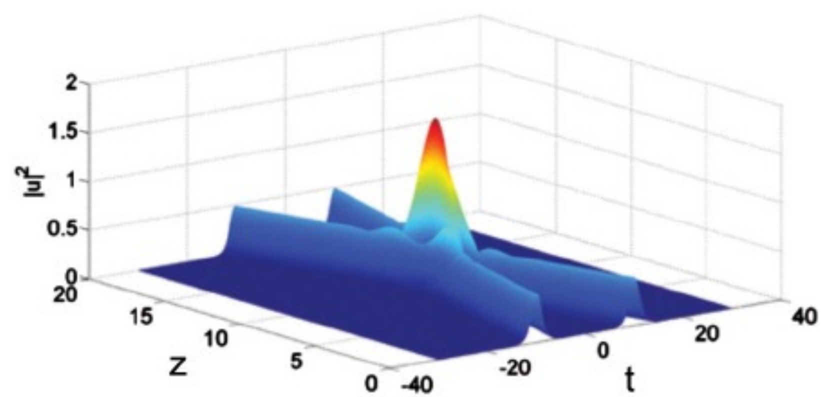
[2]Department of Physical Electronics, School of Electrical Engineering, Faculty of Engineering, Tel Aviv University, Tel Aviv 69978, Israel

$$iu_z + (1/2)u_{tt} + |u|^2 u - i\gamma u + \kappa v = 0,$$

$$iv_z + (1/2)v_{tt} + |v|^2 v + i\Gamma v + \kappa u = 0,$$



(a)



PT-Nonlinear Coupler

Letter Vol. 44, No. 3 / 1 February 2019 / Optics Letters 663

Optics Letters

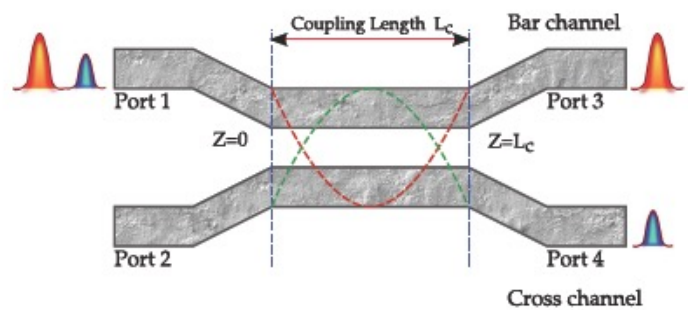
Tailoring $\mathcal{PT}$-symmetric soliton switch

A. Govindarajan,[1,*] Amarendra K. Sarma,[2] and M. Lakshmanan[1]

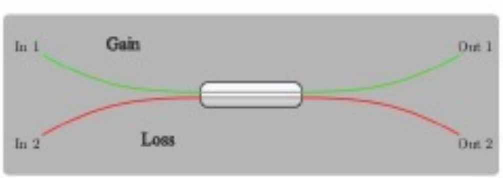
[1]Centre for Nonlinear Dynamics, School of Physics, Bharathidasan University, Tiruchirappalli-620 024, India
[2]Department of Physics, Indian Institute of Technology Guwahati, Guwahati, Assam-781039, India

$$i\frac{\partial\Psi_1}{\partial\zeta}+\frac{1}{2}\frac{\partial^2\Psi_1}{\partial\tau^2}+|\Psi_1|^2\Psi_1+\kappa\Psi_2=i\Gamma\Psi_1, \quad (1)$$

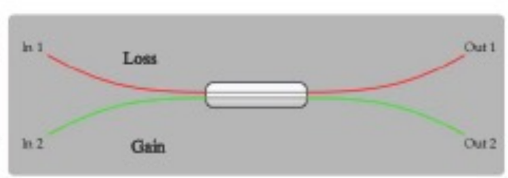
$$i\frac{\partial\Psi_2}{\partial\zeta}+\frac{1}{2}\frac{\partial^2\Psi_2}{\partial\tau^2}+|\Psi_2|^2\Psi_2+\kappa\Psi_1=-i\Gamma\Psi_2, \quad (2)$$



(c) Steering dynamics of solitons in $\mathcal{PT}$-symmetric dimers

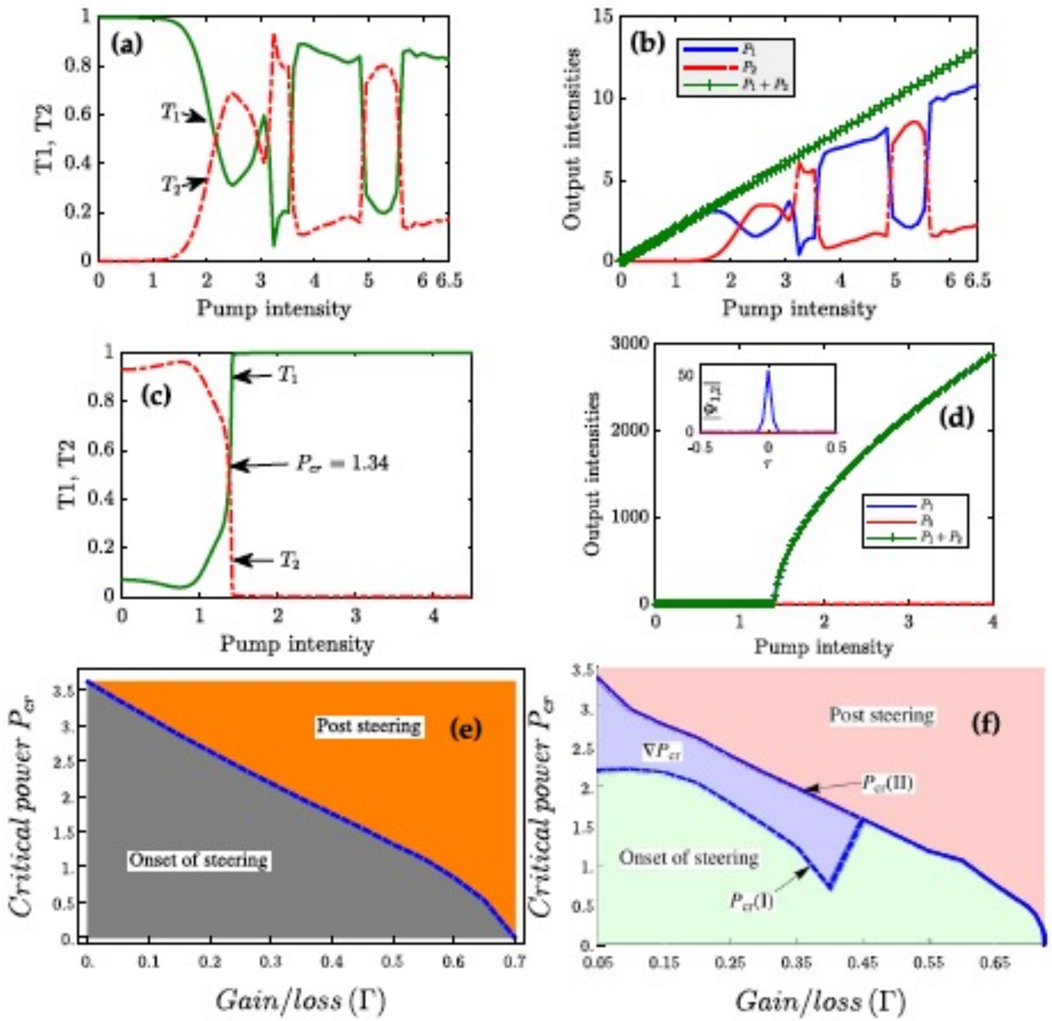


(a) Type 1 $\mathcal{PT}$-symmetric coupler



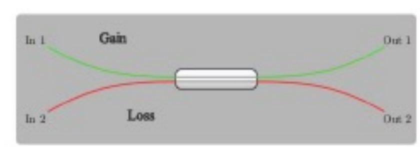
(b) Type 2 $\mathcal{PT}$-symmetric coupler

Steering Dynamics of Solitons: Type 1

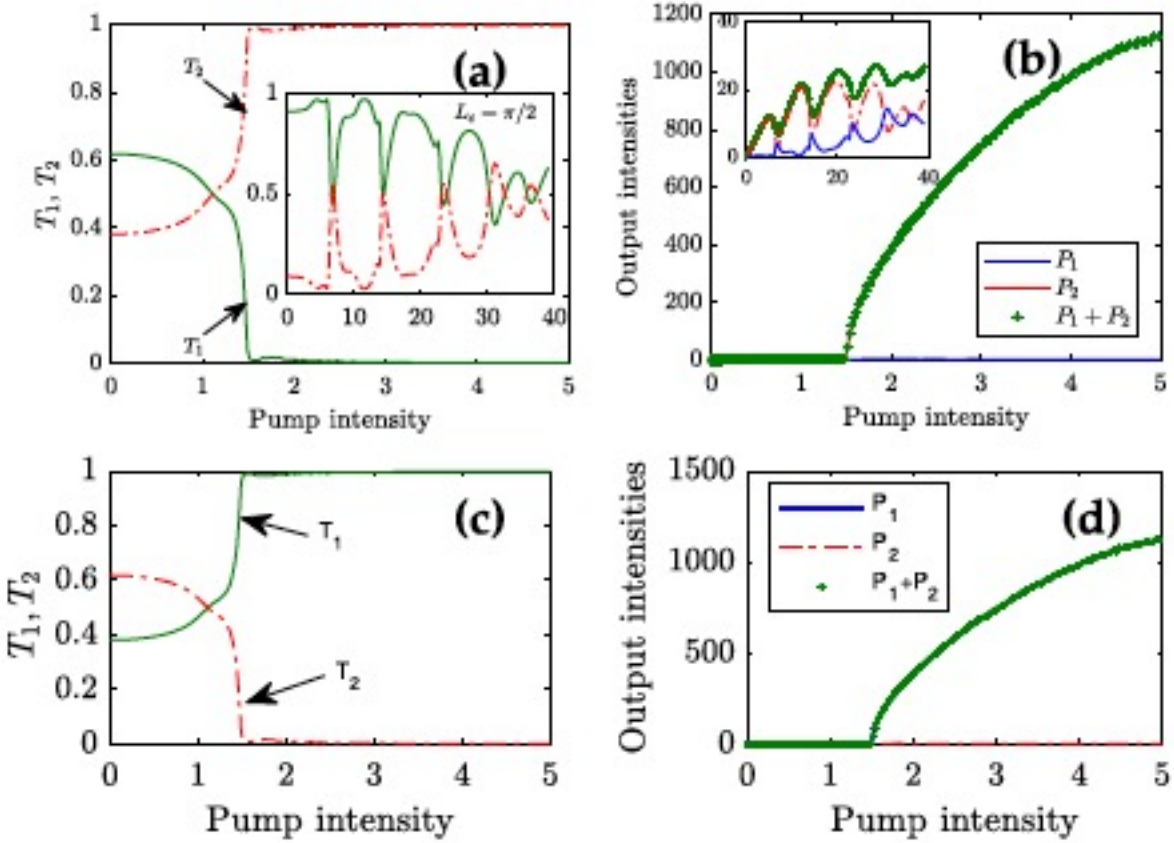


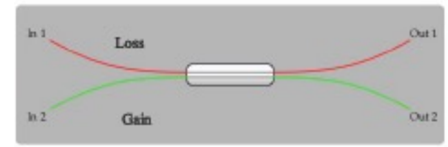
2π conventional couplers

2π $\mathcal{PT}$-symmetric couplers



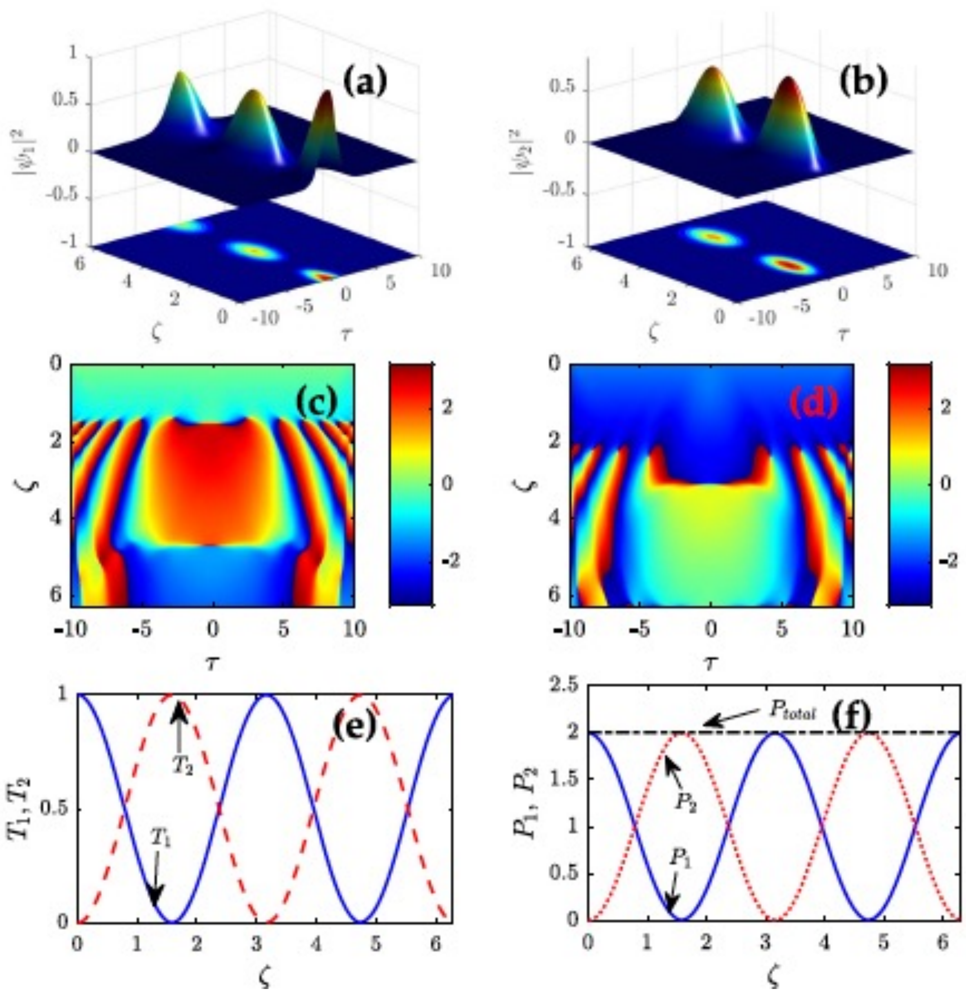
Steering Dynamics of Solitons: Type 2



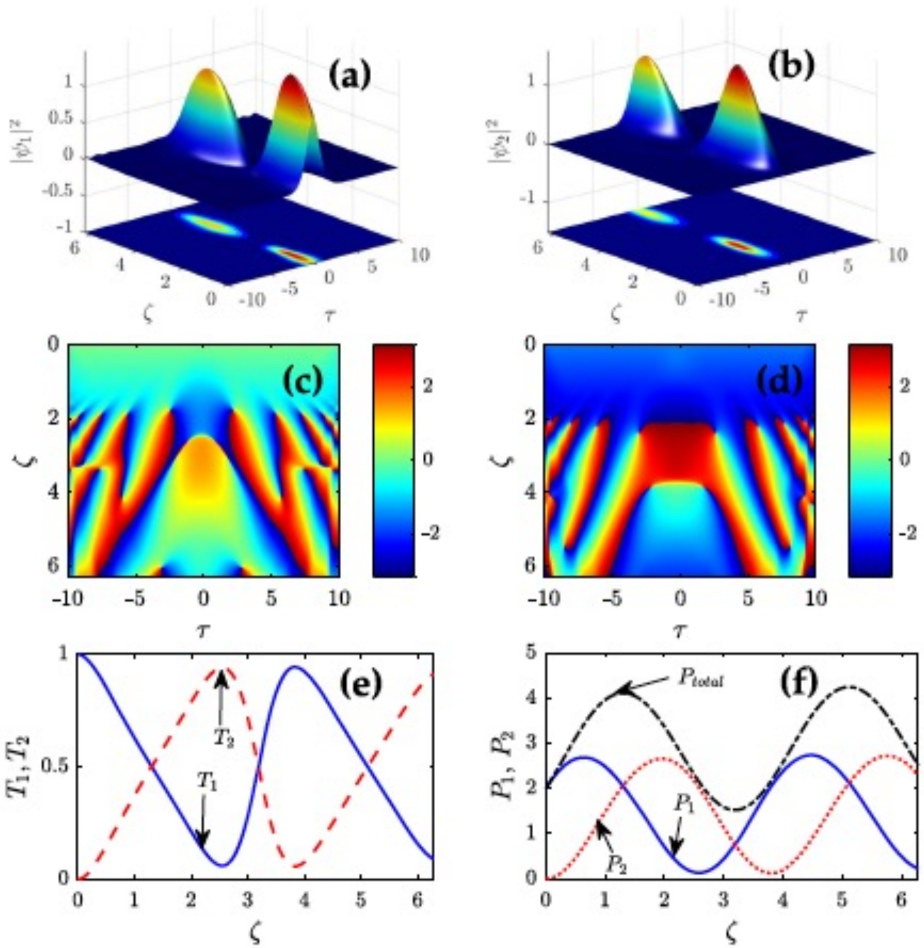


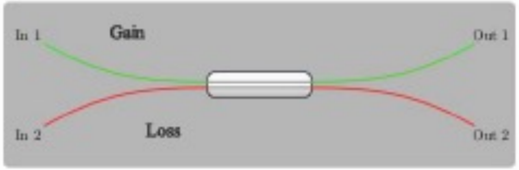
type 1 $\mathcal{PT}$ dimer with device length of 2π

Soliton Propagation Dynamics: Conventional Coupler



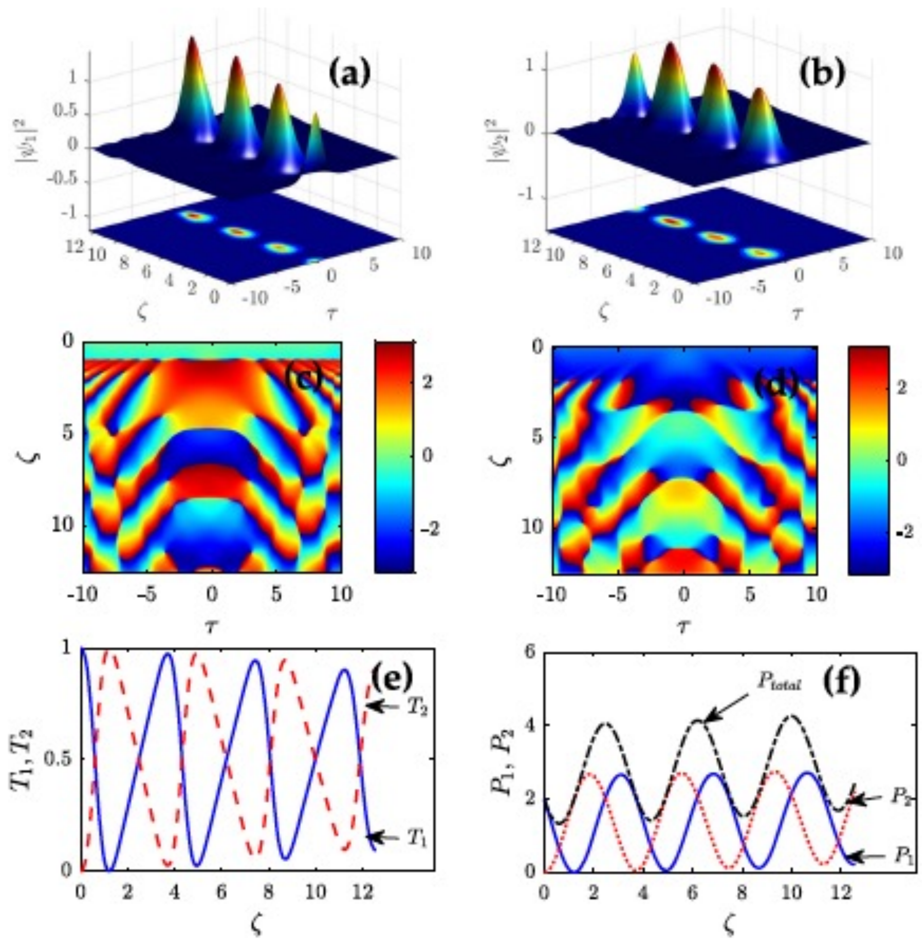
Soliton Propagation Dynamics: PT Nonlinear Coupler Type 1

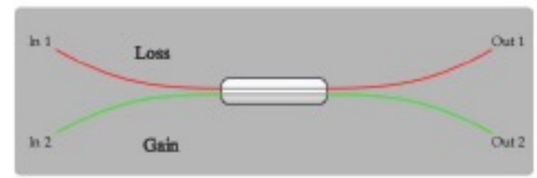




type 1 $\mathcal{PT}$ symmetry configuration

Soliton Propagation Dynamics: PT Nonlinear Coupler Type 2





Suggested Typical Parameters for Experimental Realizations

$$\beta_2 = -20\ ps^2/km$$
$$\lambda = 1550\ nm$$

$$T_0 = 50\ fs$$
$$L_D = 12.5\ cm$$

$$\gamma = 10\ W^{-1}/km$$

$$P_{cr} = 8.56\ W$$

Dark Soliton Steering

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OPTICAL PHYSICS

Dark soliton steering in $\mathcal{PT}$-symmetric couplers with third-order and intermodal dispersions

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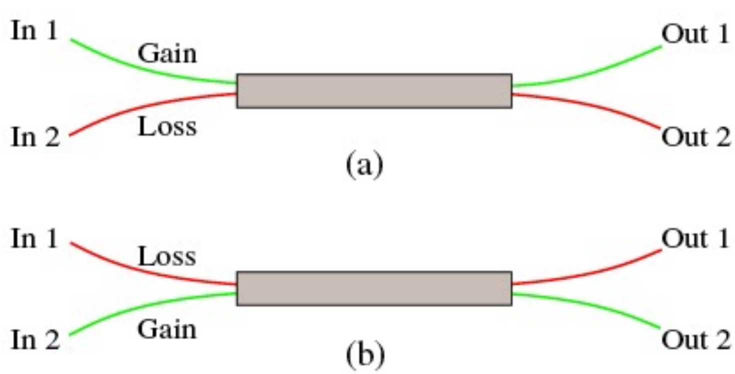
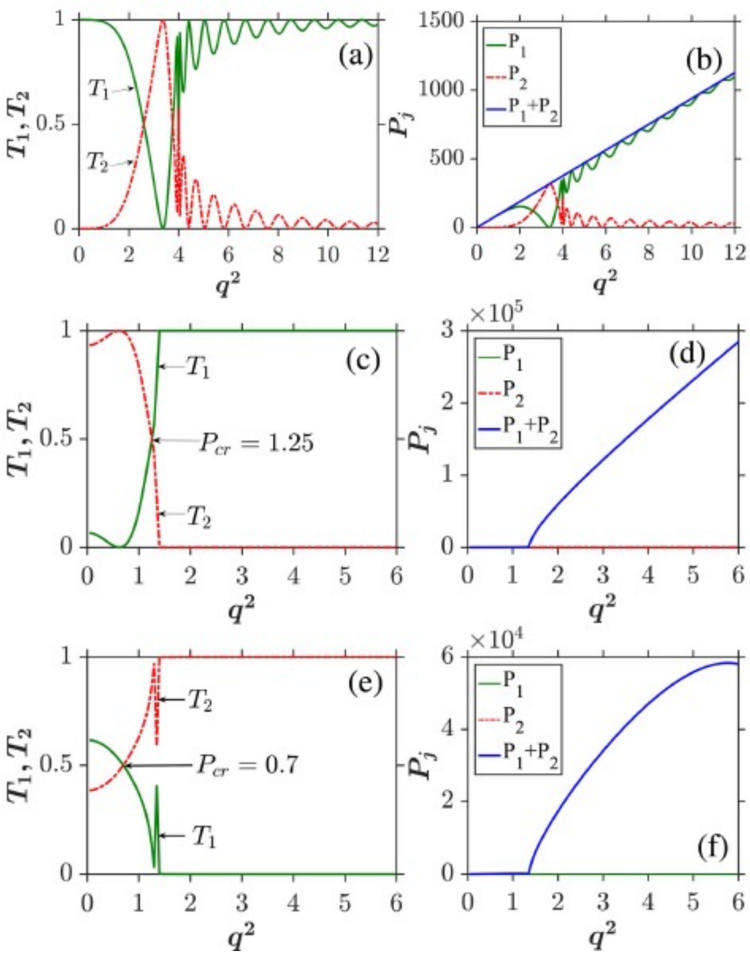


Steering Dynamics of Dark Solitons



conventional coupler,

Type 1 $\mathcal{PT}$-symmetric couplers,

Type 2 $\mathcal{PT}$-symmetric couplers

TO SUM UP:

We demonstrate steering dynamics of dark solitons in a parity–time ($\mathcal{PT}$)-symmetric nonlinear directional coupler (NLDC) in the presence of third-order dispersion (TOD) and intermodal dispersion (IMD). A complete switch with an excellent efficiency at a very low critical power, even lower compared to the bright soliton switching, has been observed. The numerical results show that both TOD and IMD have no effect on soliton steering in $\mathcal{PT}$-symmetric couplers with coupling length $\pi/2$. But, as we increase the coupling length to 2π, IMD shows marginal effects for dark soliton steering in $\mathcal{PT}$-symmetric couplers, while TOD shows no impact. Additionally, we have also studied the phase-controlled switching in $\mathcal{PT}$-symmetric couplers with two different coupling lengths and demonstrated its advantage over the power-controlled one.

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Ultrashort Soliton Steering in PT-Nonlinear Coupler

The pulse propagation in a realistic PT-symmetric fiber-coupler is represented by generalised coupled NLSE:

$$i\frac{\partial u}{\partial \xi} + \sum_{n=2}^{\infty} \delta_n \left(i\frac{\partial}{\partial \tau}\right)^n u - i\Gamma u + \left(1 + is\frac{\partial}{\partial \tau}\right)\left(u(\xi,\tau)\int_{-\infty}^{\tau} R(\tau-\tau')|u(\xi,\tau')|^2 d\tau'\right) + \kappa v = 0,$$

$$i\frac{\partial v}{\partial \xi} + \sum_{n=2}^{\infty} \delta_n \left(i\frac{\partial}{\partial \tau}\right)^n v + i\Gamma v + \left(1 + is\frac{\partial}{\partial \tau}\right)\left(v(\xi,\tau)\int_{-\infty}^{\tau} R(\tau-\tau')|v(\xi,\tau')|^2 d\tau'\right) + \kappa u = 0.$$

- u,v = field envelopes in the bar and cross channel
- δ_n = Normalised GVD and higher-order dispersion parameters
- s = Self-steepening parameter
- R(τ) = Nonlinear response function
- κ = Normalized linear coupling coefficient
- Γ = Gain/Loss

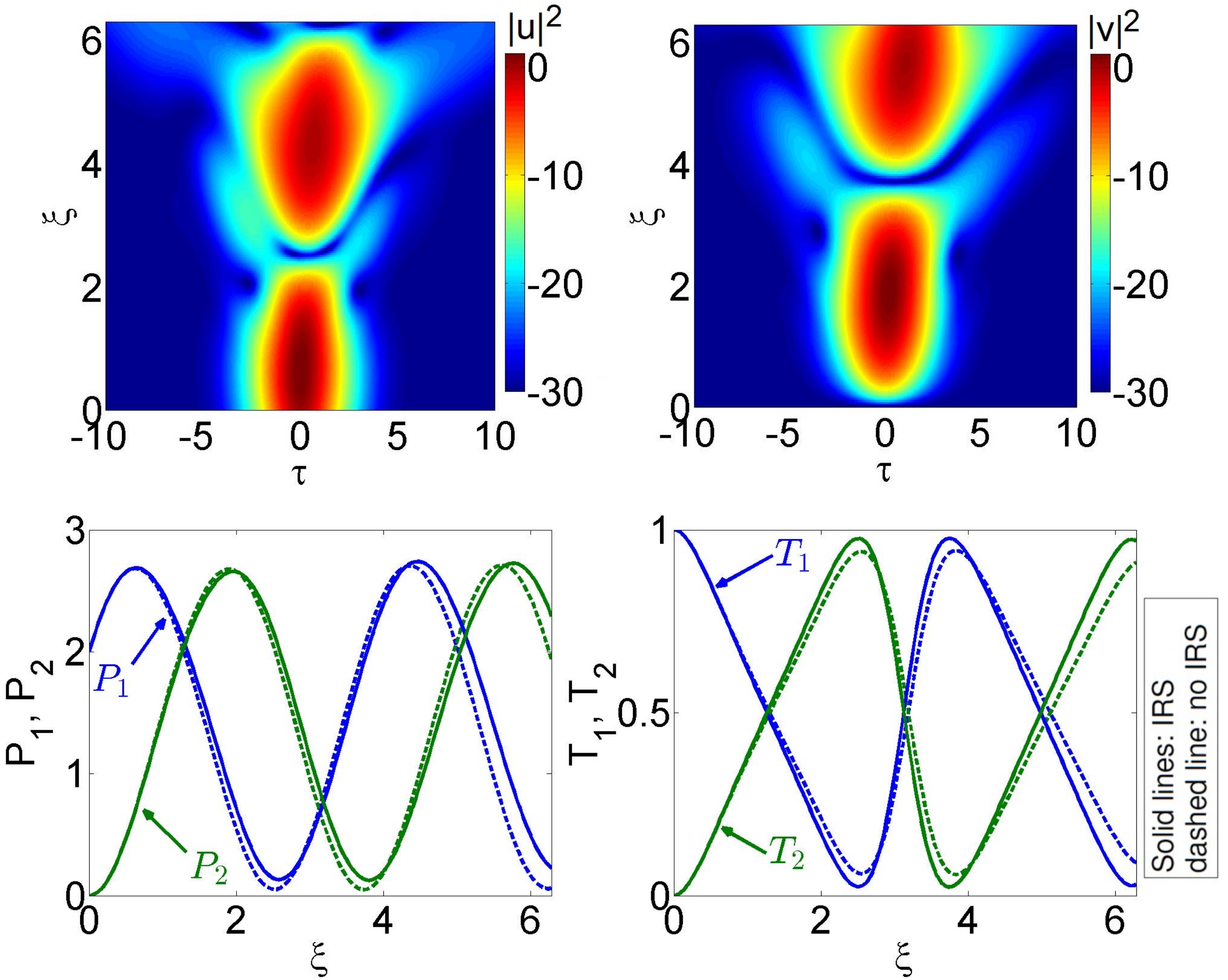
Which Model to Choose?

$$\frac{\partial A}{\partial z} + \frac{1}{2}\left(\alpha(\omega_0) + i\alpha_1\frac{\partial}{\partial t}\right)A - i\sum_{n=1}^{\infty}\frac{i^n\beta_n}{n!}\frac{\partial^n A}{\partial t^n}$$
$$= i\left(\gamma(\omega_0) + i\gamma_1\frac{\partial}{\partial t}\right)\left(A(z,t)\int_0^{\infty}R(t')|A(z,t-t')|^2 dt'\right)$$

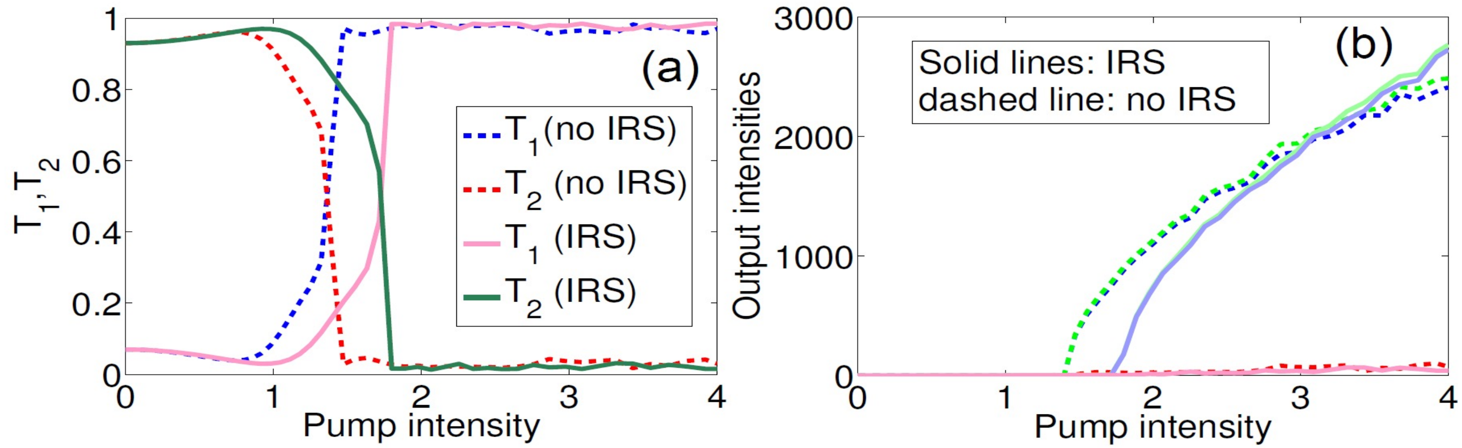
$$\frac{\partial A}{\partial z} + \frac{\alpha}{2}A + \frac{i\beta_2}{2}\frac{\partial^2 A}{\partial T^2} - \frac{\beta_3}{6}\frac{\partial^3 A}{\partial T^3} = i\gamma\left(|A|^2 A + \frac{i}{\omega_0}\frac{\partial}{\partial T}(|A|^2 A) - T_R A\frac{\partial |A|^2}{\partial T}\right)$$

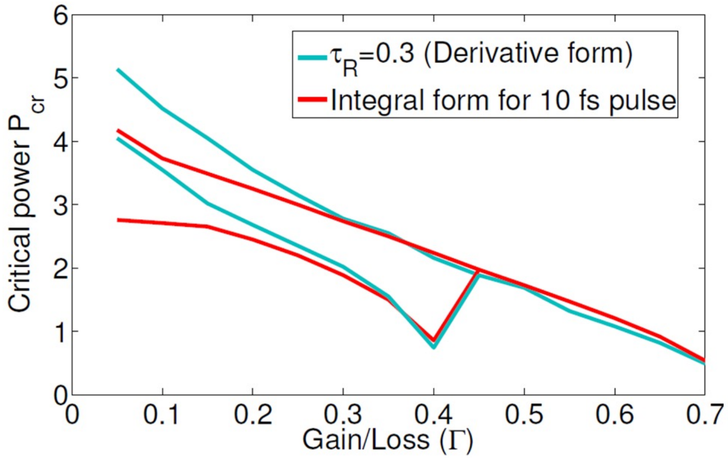
Effect of Intrapulse Raman Scattering (IRS)

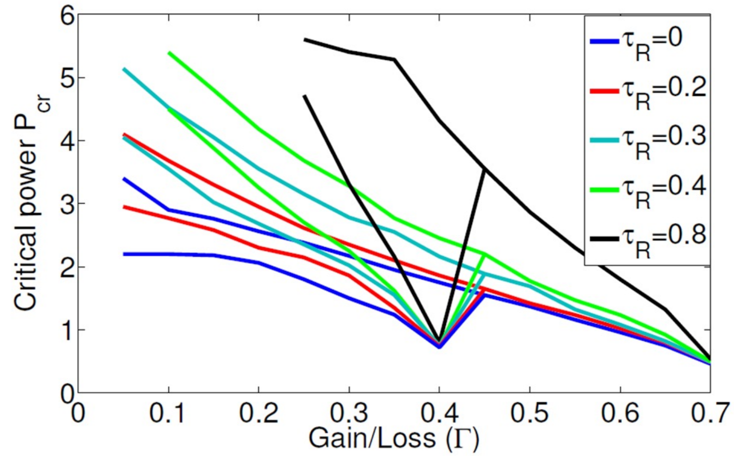
$t_0 = 10\text{fs}$



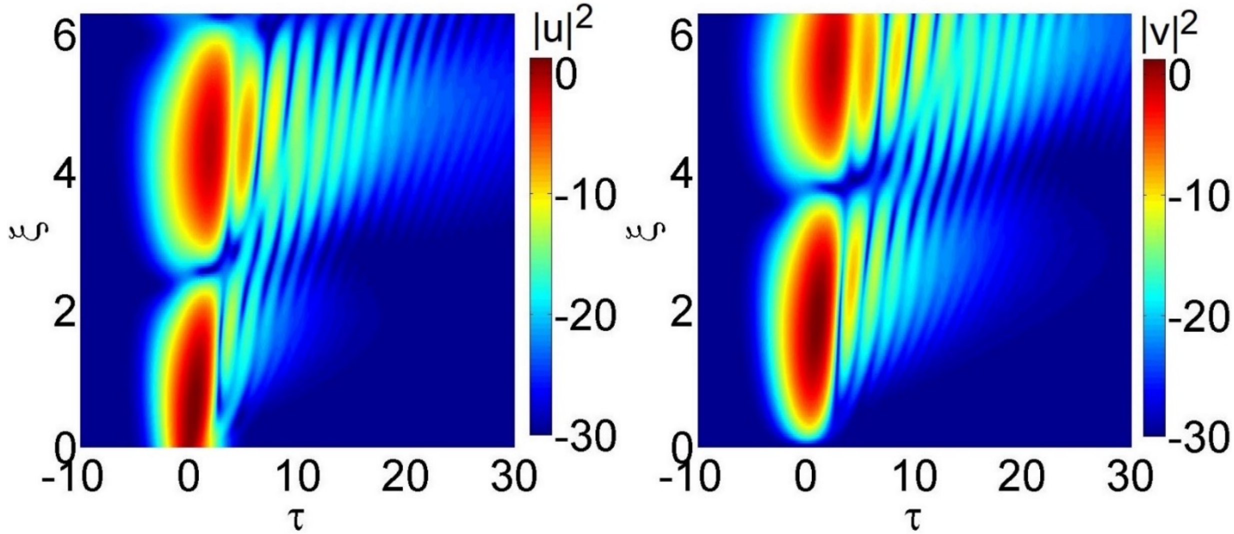
Effect of Intrapulse Raman Scattering (IRS)

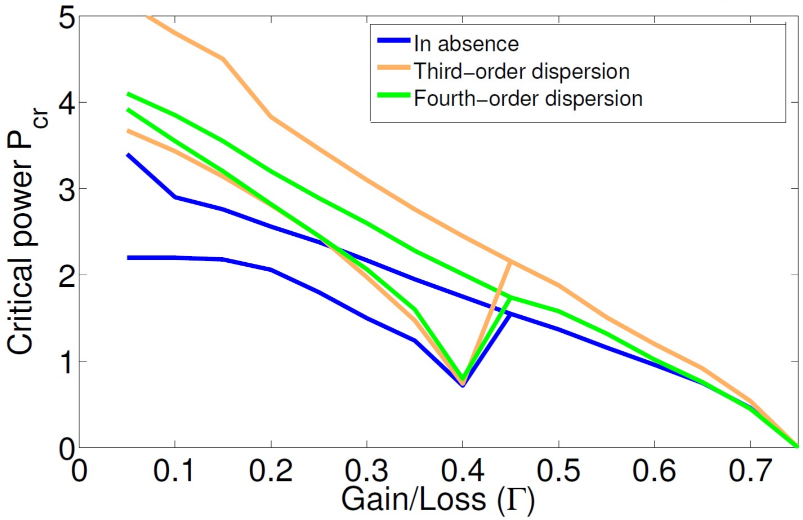






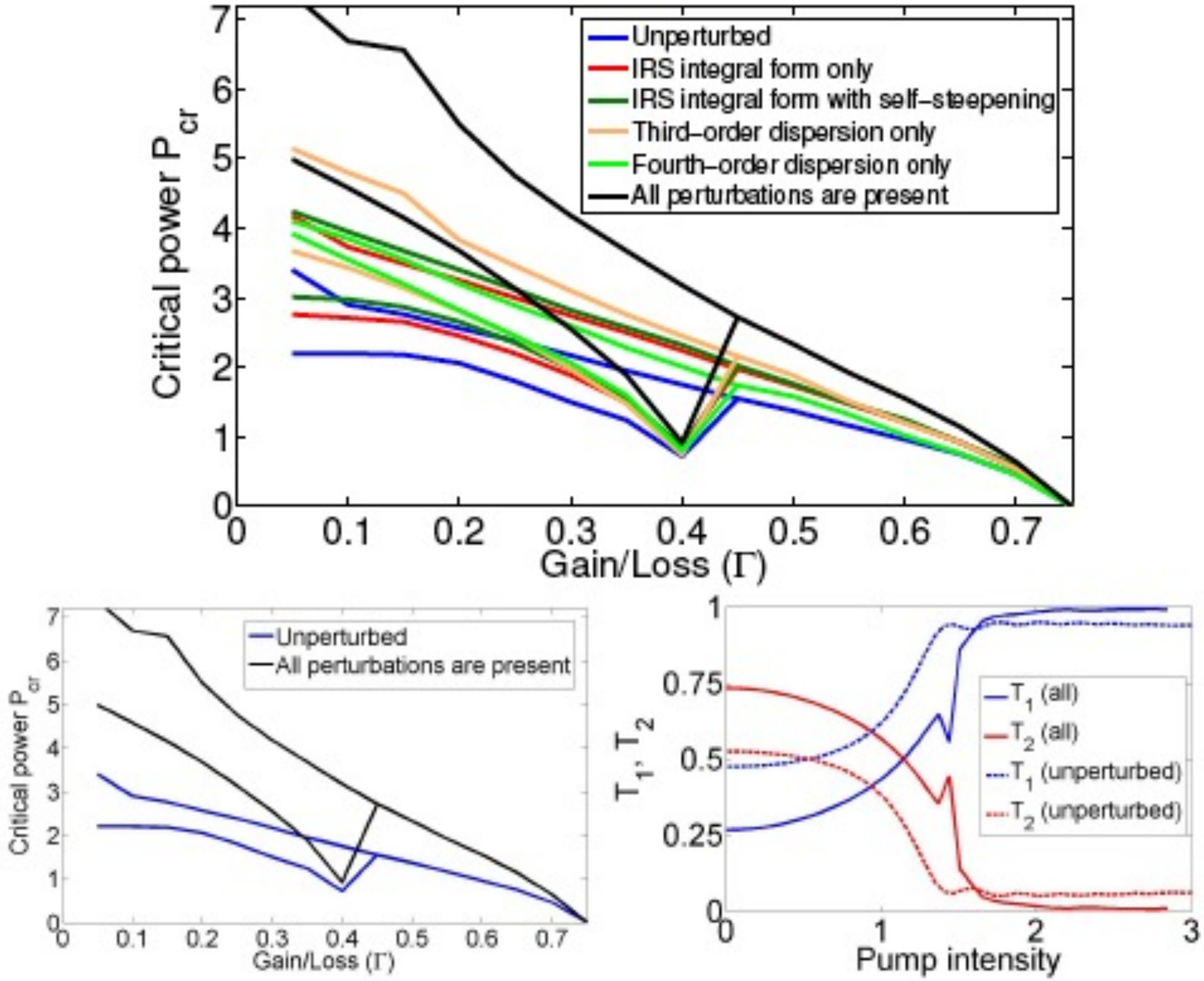
Effect of Higher-order dispersion





$\delta_3 = 0.3444$

$\delta_4 = 0.0447$


Unperturbed
IRS integral form only
IRS integral form with self–steepening
Third–order dispersion only
Fourth–order dispersion only
All perturbations are present
Critical power P_{cr}
Gain/Loss (Γ)
Unperturbed
All perturbations are present
Critical power P_{cr}
Gain/Loss (Γ)
T_1 (all)
T_2 (all)
T_1 (unperturbed)
T_2 (unperturbed)
T_1, T_2
Pump intensity

Saturating nonlinearity (SNL)

Kerr-Nonlinear medium	Saturating Nonlinear medium
$\Delta n_{NL} = n_2 \lvert E \rvert^2$	$\Delta n_{NL} = \frac{n_2 \lvert E \rvert^2}{1+\frac{\lvert E \rvert^2}{I_{sat}}}$

- Critical power of switching (P_{cr}) depends on the input peak power.
- For Silica, n_2 value is relatively low, thus input pulse with high peak power is required for switching from one channel to the other.
- Use of materials such as Semiconductor doped Silica and organic polymers with high n_2 value can decrease the requirement of high input power.

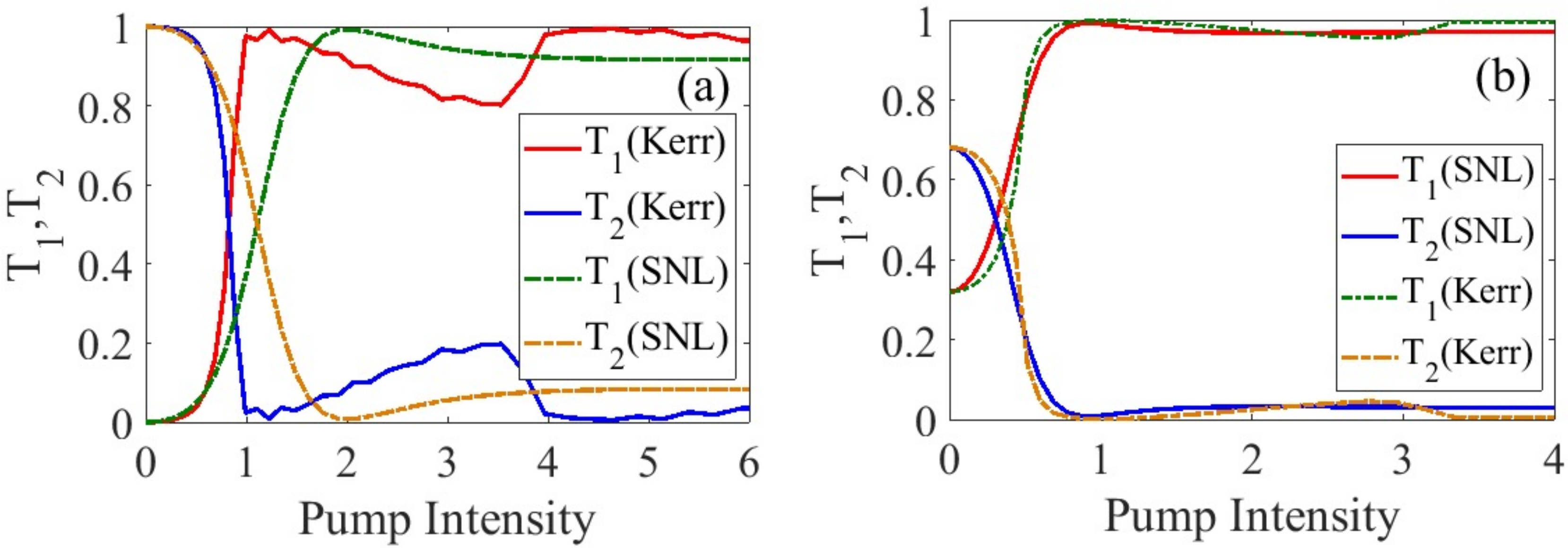
Mathematical Model

The pulse propagation in a PT-symmetric fiber-coupler with saturating nonlinearity is represented by coupled NLSE:

$$i\frac{\partial u}{\partial \xi}+\frac{1}{2}\frac{\partial^2 u}{\partial \tau^2}+f(|u|^2)u+\kappa v=i\Gamma u \quad (1)$$

$$i\frac{\partial v}{\partial \xi}+\frac{1}{2}\frac{\partial^2 v}{\partial \tau^2}+f(|v|^2)v+\kappa u=-i\Gamma v \quad (2)$$

- $f(|u|^2)$ = saturating nonlinearity function = $\frac{|u|^2}{1+s|u|^2}$ (F-Model)
- Eqs. (1) and (2) are solved Numerically using SSFT method.
- All the results shown are for the Type-1 PT-symmetric coupler in the Unbroken regime with $\kappa(0.1) > \Gamma(0.05)$.

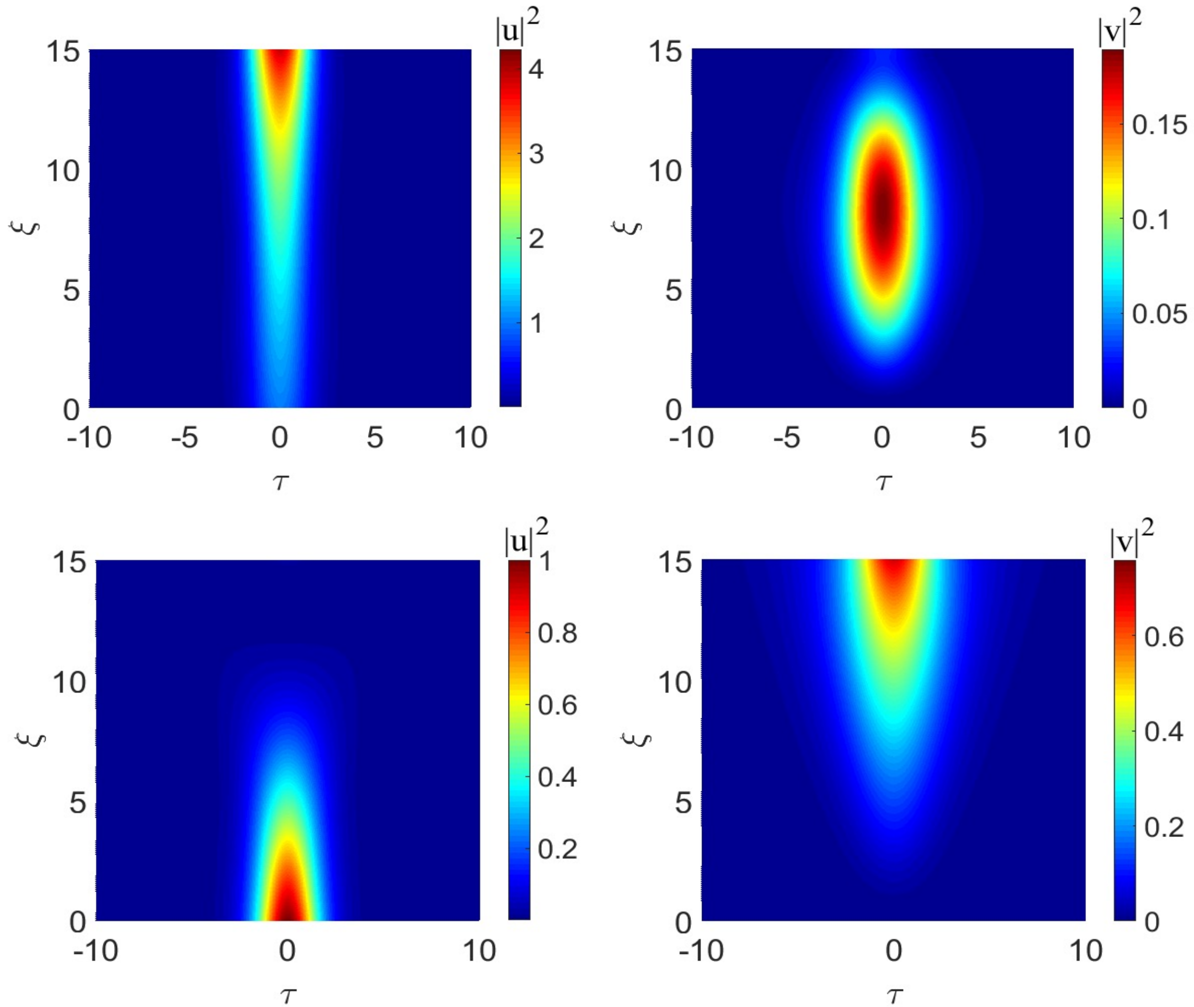


PT with Saturating Nonlinearity wins!

Coupling length = π/2, κ=0.1	Conventional coupler	Type 1 PT-coupler	Type 2 PT-coupler **(not shown here)**
Kerr Nonlinearity	0.83	0.38	Incomplete
Saturating Nonlinearity	1.11	0.30	3.65,16.77

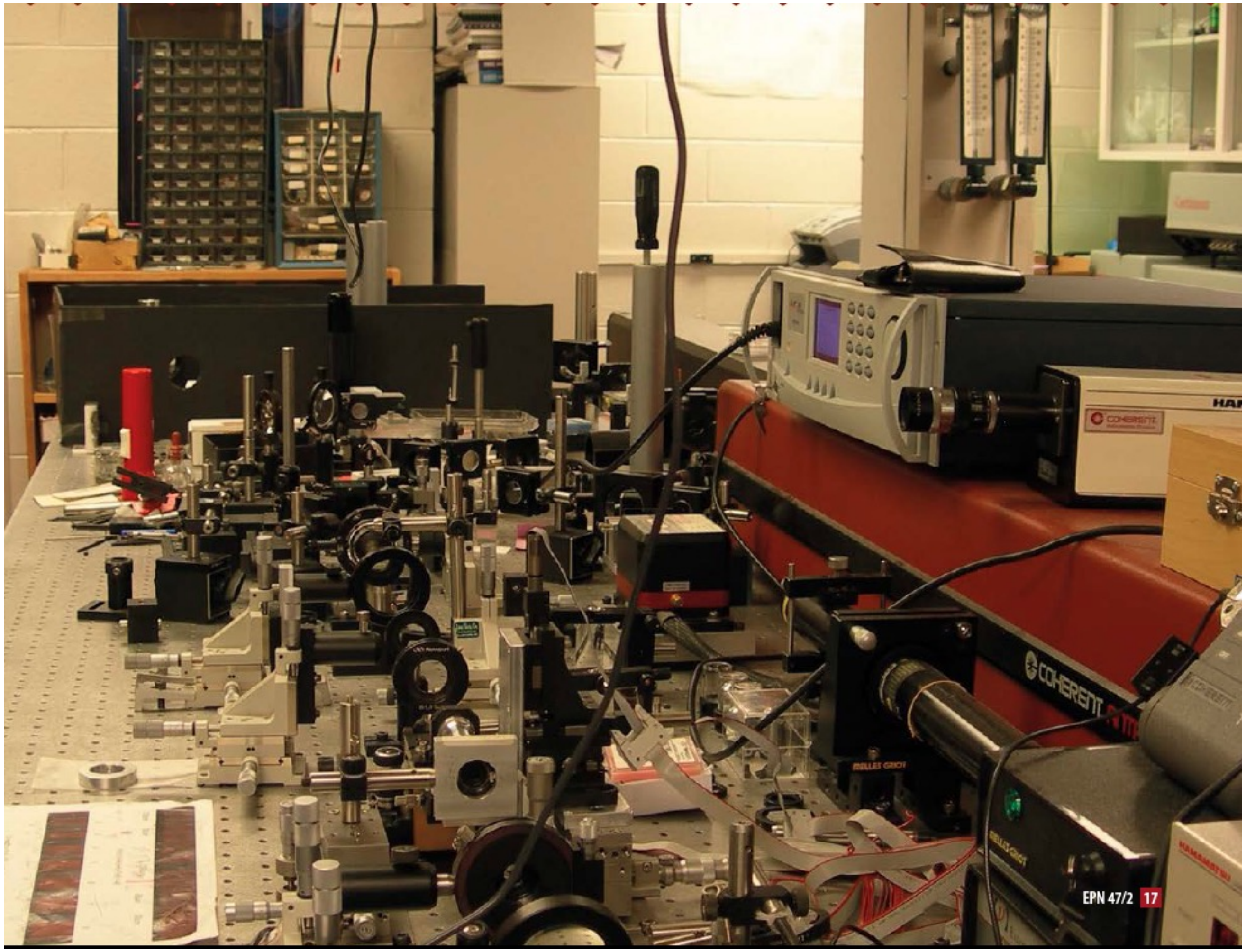
Soliton evolution inside Type-1 and Type-2 PT coupler

K=0.1,Γ=0.05



Future Directions and Goals

- To understand the physics of Nonlinear coupler more deeply
- To come up with practical schemes for facilitating experiments
- To go beyond Fiber Coupler
- Soliton Steering and Switching in Quantum Regime?



THANK YOU!