



# Nonlinear MZI as a DPSK Signal Regenerator for Optical Communications

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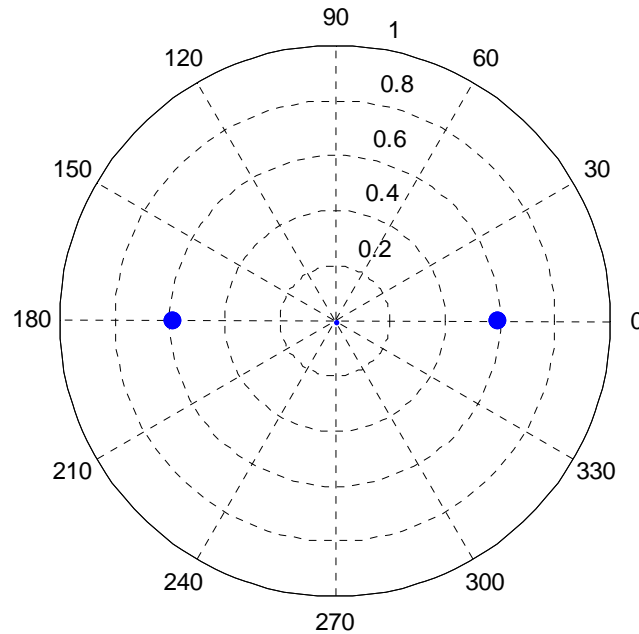
MERIT 2006 (UMCP)

# Questions to be answered

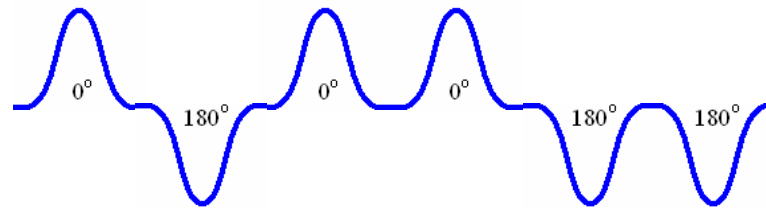
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- What is differential phase-shift keying (DPSK)?
- How does a nonlinear Mach-Zehnder interferometer (MZI) work?
- How can a nonlinear MZI be used for DPSK regeneration?
- What kinds of nonlinear media provide good regeneration?

# DPSK is an optical modulation scheme that encodes data in phase changes



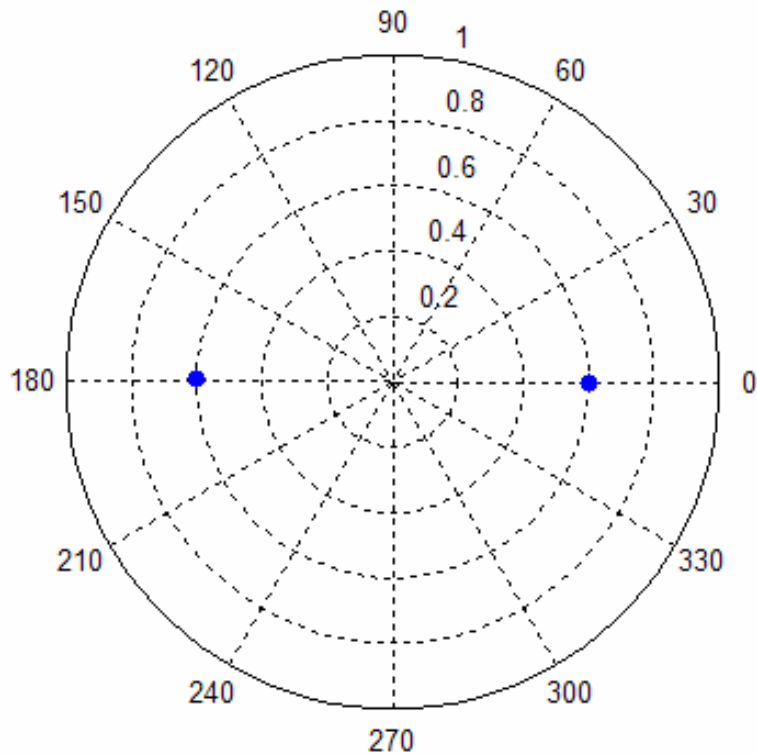
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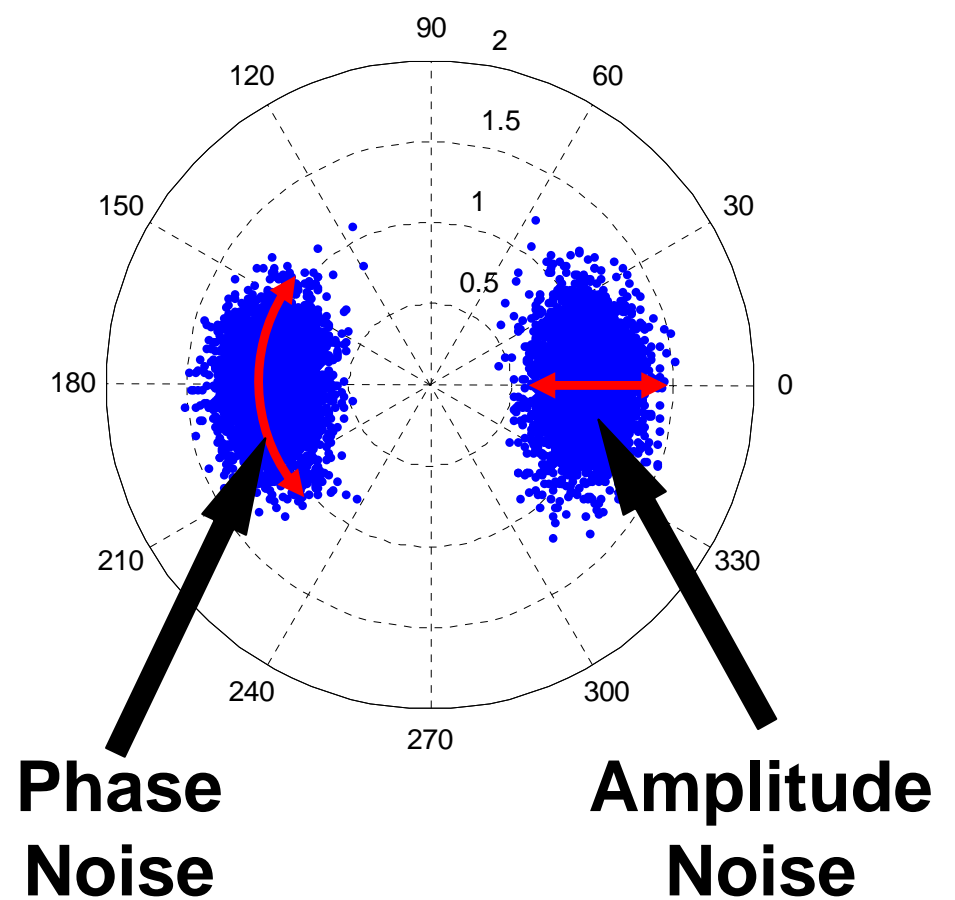
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# DPSK signals are affected by both phase and amplitude noise

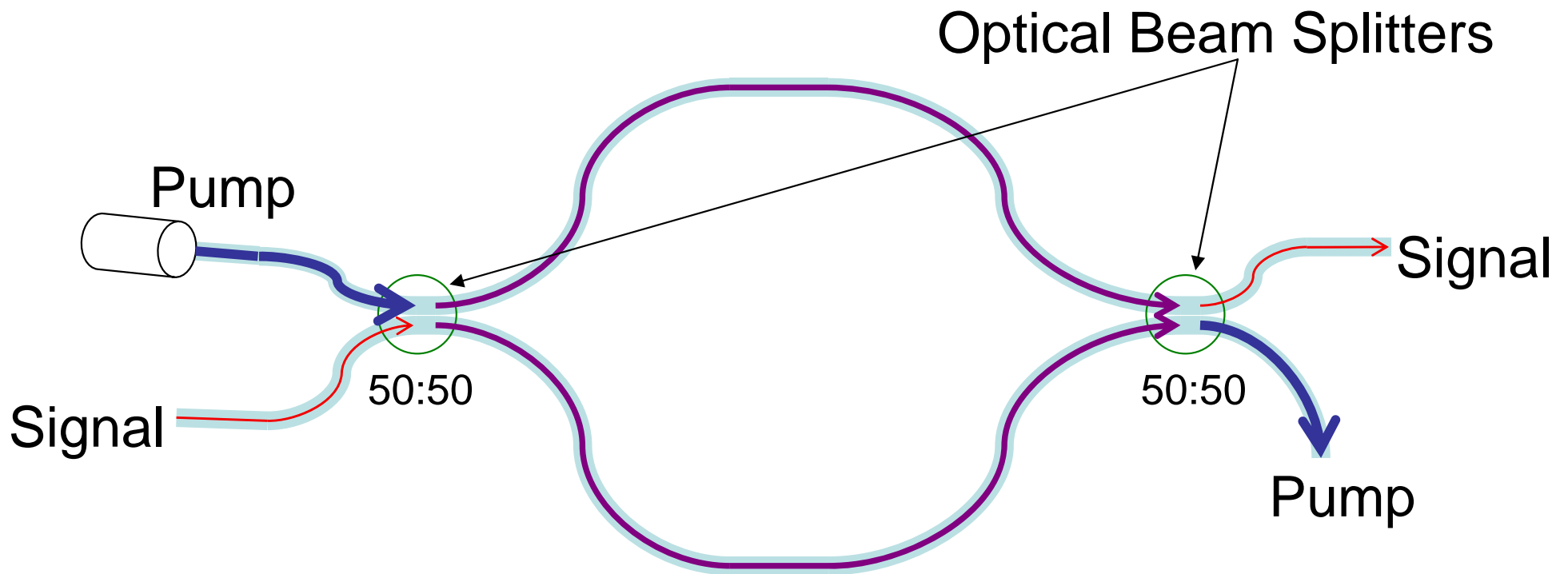
Noiseless DPSK Signal



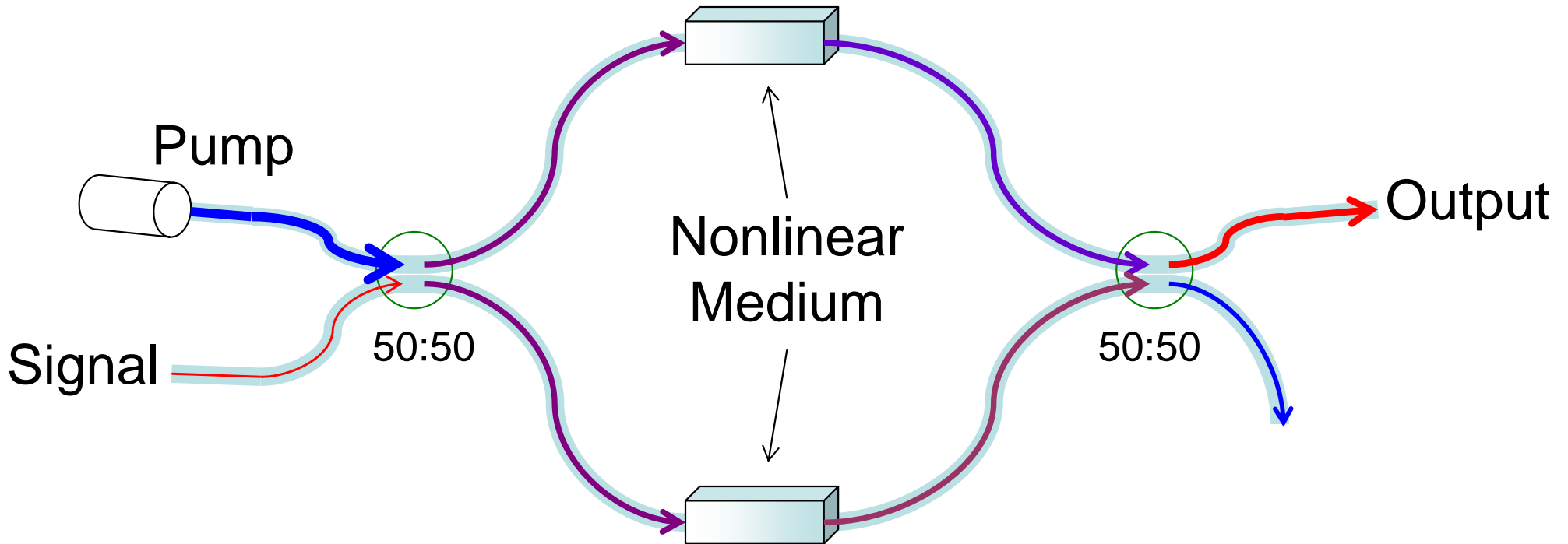
Noisy DPSK Signal



In the linear MZI signal inputs are mixed and then separated back out



# Interference from nonlinear media unbalance the MZI causing it to act like a switch



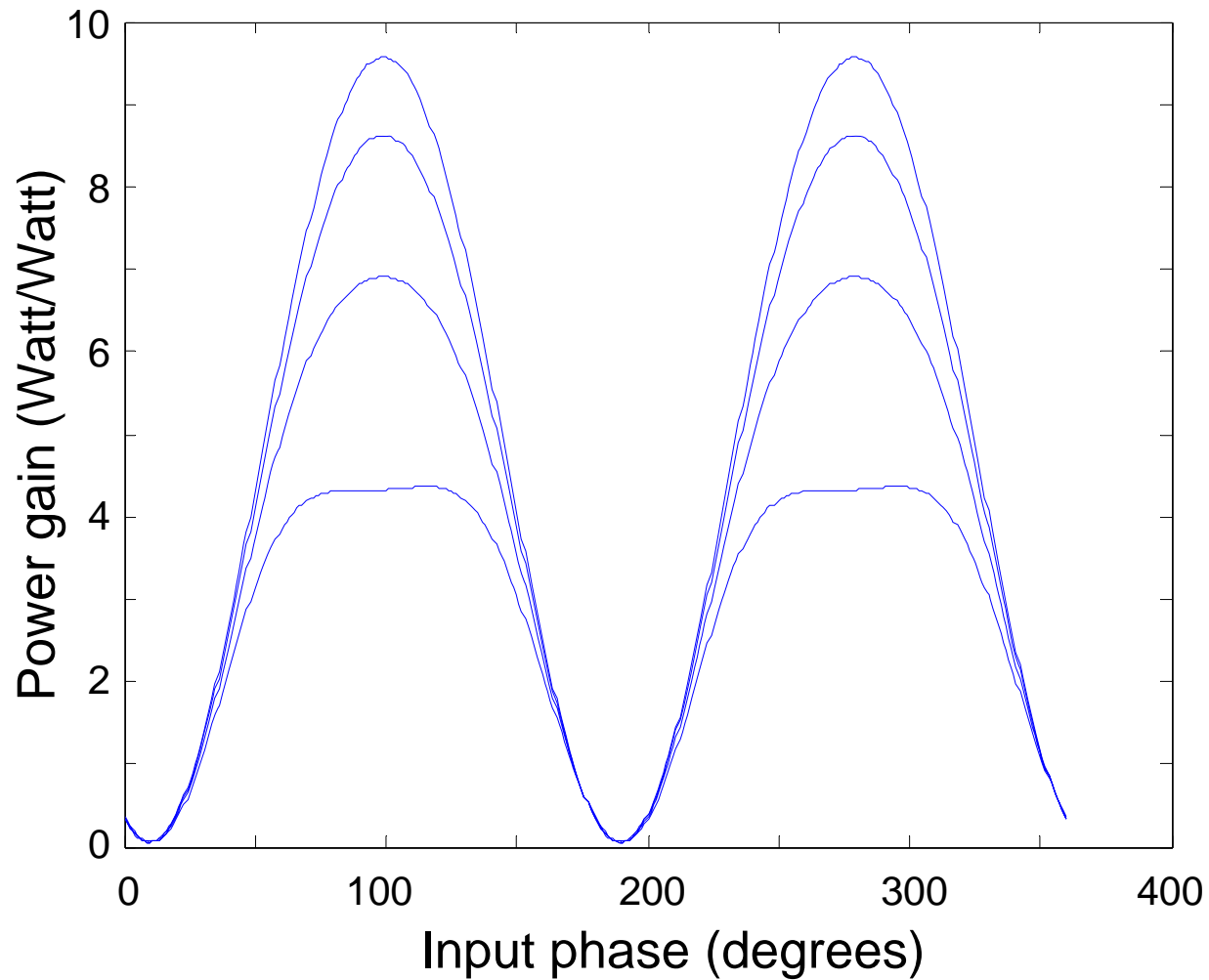
The Output...

- is a combination of the signal and the pump
- depends on input intensity and phase

Computer simulation indicates that in saturation both phase and amplitude noise can be reduced

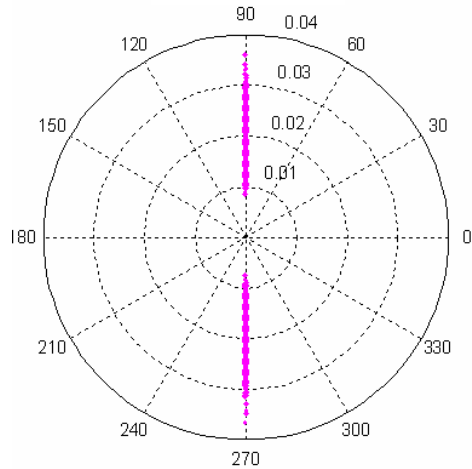
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Phase-sensitive amplifier going into saturation

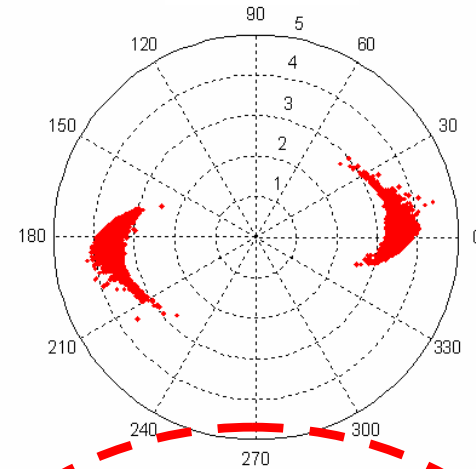


# Modeling shows how well different nonlinear media perform in a regenerator

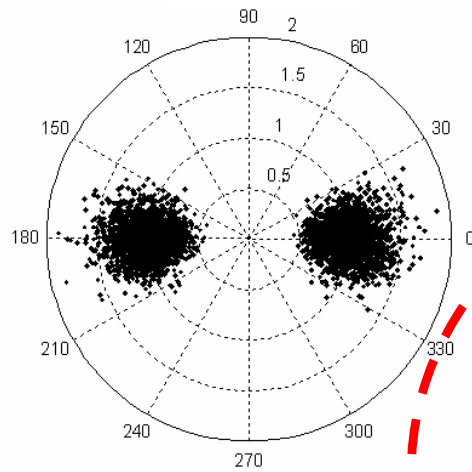
## Two-Photon Absorber



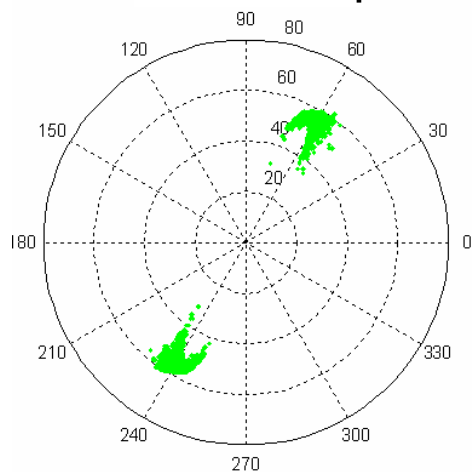
## Kerr Media



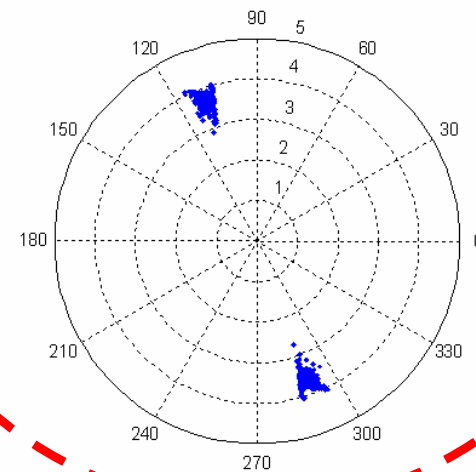
## Non-Regenerated



## Saturable Amplifier



## Saturable Absorber





# Summary

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- A computer model was developed for the simulation of MZI-based all optical regeneration
- Regeneration using different nonlinear media in the MZI was compared
- All nonlinear media considered could provide phase-only regeneration
- The saturable absorber cleaned up both phase and amplitude noise better than any of the other three nonlinear media