Soliton Research at the Lightwave Communication Systems Laboratory

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Summary

• Introduction to optical solitons
• The KU soliton generator
• The KU recirculating loop
• Preliminary soliton transmission results
• Summary and suggestion for future work
Optical Solitons

An optical soliton is a short, high-amplitude optical pulse that does not spread as it propagates.
Linear, Dispersive Fiber
Kerr Effect and Chirp

Amplitude Profile

Kerr Phase

Instantaneous Frequency

Front

Back

$t \rightarrow$

$t \rightarrow$
Nonlinear, Nondispersive fiber

![Graph showing intensity over time and frequency]

Intensity vs. Time and Frequency vs. Length
Nonlinear Fiber with Positive Dispersion
Fundamental Soliton
Soliton-based optical fiber transmission

Achieved error free distances in single-channel and WDM
Three Types of Soliton Generators

1. Soliton laser based on mode-locking

2. Electroabsorption Modulator-based soliton generators

3. LiNbO$_3$ Mach-Zehnder Modulator-based soliton generators
Mach-Zehnder Soliton Generator

Diagram:
- Port a
- Port b
- CW light in
- V_a
- V_b
- Dispersive fiber
- Optical pulses
- Compressed pulses

Lightwave Laboratory
Amplitude Modulation

Transfer Function

Output pulse shape

Sinusoidal voltage
Pulse Compression

Pulsewidth

Bandwidth

Product of Both

peak-to-peak phase modulation (π)
Structure and Operation

Title:
/tmp/xfig-fig015248
Creator:
fig2dev
Preview:
This EPS picture was not saved with a preview included in it.
Comment:
This EPS picture will print to a PostScript printer, but not to other types of printers.
KU Soliton Generator
Mearsured Pulse Compression

Uncompressed pulses

Compressed pulses
Soliton Source: Output

Soliton Train

Data Encoded Soliton Sequence
20GHz Time/polarization Division Multiplexed Soliton Train

PM fiber

Polarization of Incident Light
Soliton Generator For WDM
Recirculating Loop
KU Recirculating Loop Testset
OC48 Rate Transmission Emulation

Standard Fiber

75 km: Error Free

600 km: Error Free
(BER < 2 \times 10^{-13})

1050 km: BER = 2 \times 10^{-10}

1350 km: BER = 3 \times 10^{-7}
Measured, Near-Soliton Characteristics

Transmitter

20 ps/div

4*35 km High Power

Launch power: 8 dBm

6*35 km Low Power

Launch power: -2.5 dBm
Future Work

1. Long-distance 10 Gb/s or time/polarization-division-multiplexed soliton transmission in alternating positive and negative dispersion fiber links.

2. 10 Gb/s or 20 Gb/s WDM transmission in dispersion-compensated standard fiber link with long amplifier spans.

3. Experimental demonstration of soliton control for all-optical networks.