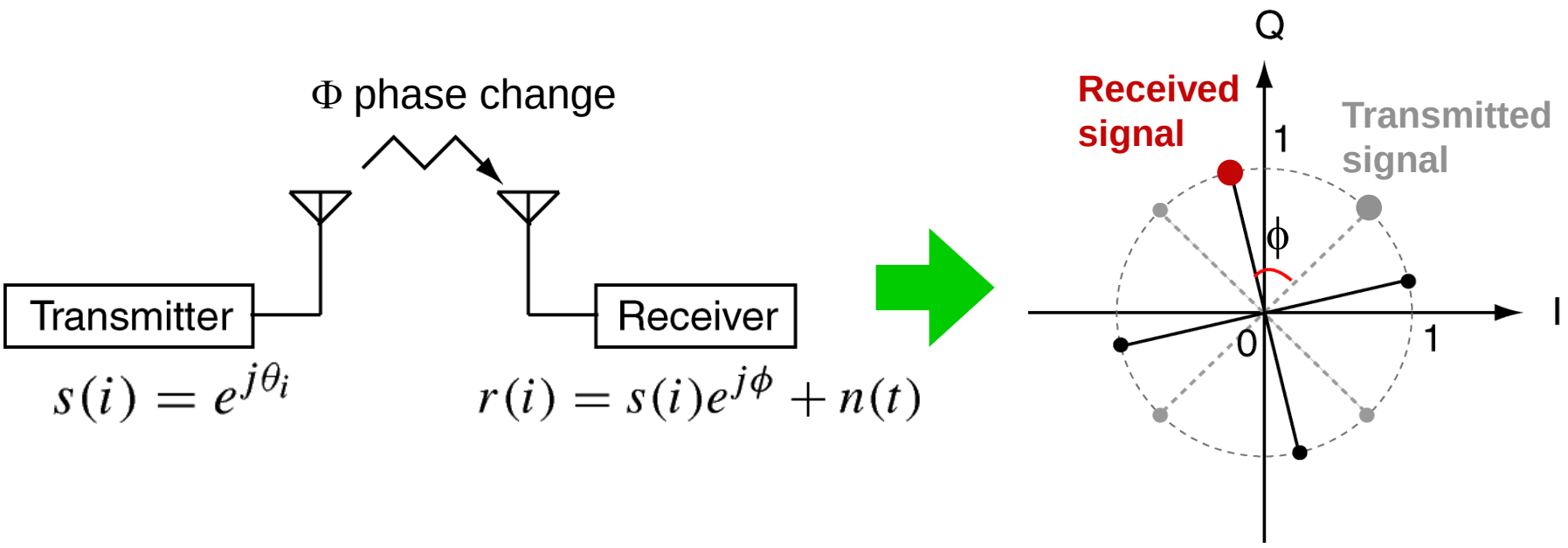
2nd seminar for foreign students
Non-coherent demodulation in AWGN channel

Suzuki - Fukawa Laboratory /
June 19, 2012

Main point of non-coherent detection

If the phase is changed by ϕ in transmission line



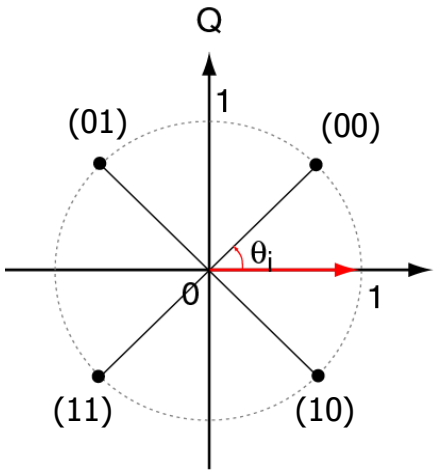
If this phase change is not taken into account in coherent detection, the signal could not be detected correctly

Differential encoding QPSK

QPSK

Modulate the phase of data

$$s(i) = \exp(j\theta_i)$$



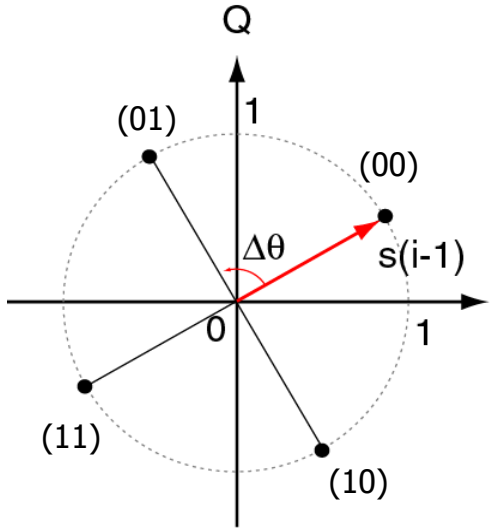
	θ_ι
00	$\pi/4$
01	$3\pi/4$
11	$5\pi/4$
10	$7\pi/4$

DQPSK

Modulate phase difference data from previous symbol

$$s(i) = \exp(j\theta_i)$$
$$= \exp\{ j(\theta_{i-1} + \Delta\theta_i)\}$$

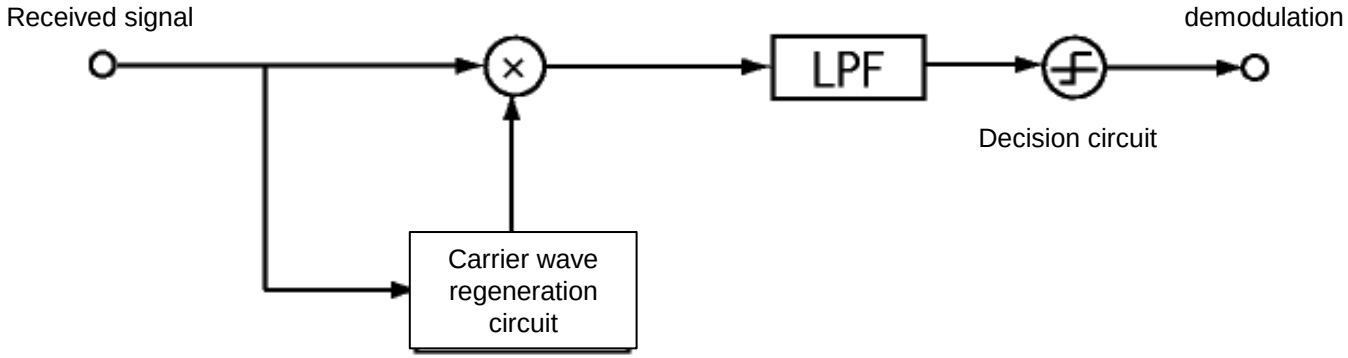
Phase diff.



	$\Delta\theta_\iota$
00	0
01	$\pi/2$
11	π
10	$3\pi/2$

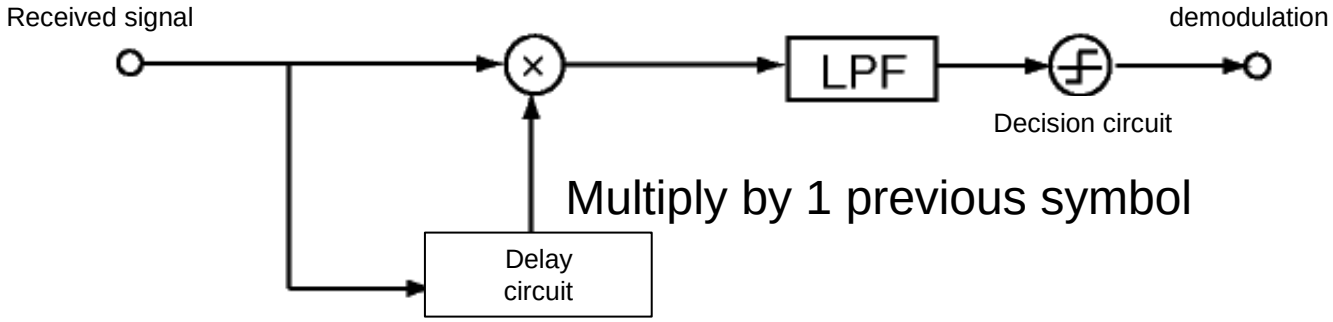
Non-coherent detection

◆Coherent detection



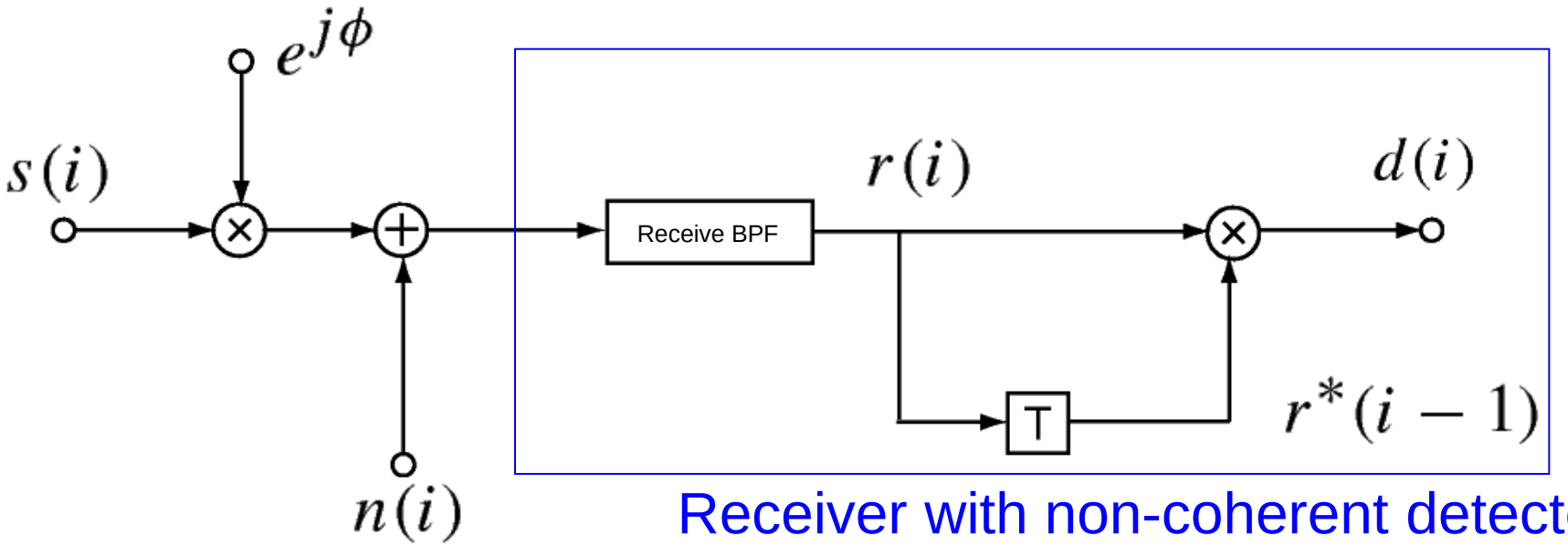
Carrier wave needs to be regenerated

◆Non-coherent detection



Carrier wave needs not to be regenerated in receiver

Differential encoding and non-coherent detection



Receiver with non-coherent detector

$$
\begin{aligned}
d(i) &= r(i)\cdot r^*(i-1) \\
&= \{s(i)e^{j\phi} + n(i)\} \cdot \{s(i-1)e^{j\phi} + n(i-1)\}^* \\
&= s(i)s^*(i-1) + \underline{s(i)n^*(i-1)e^{j\phi} + s^*(i-1)n(i)e^{-j\phi} + n(i)n^*(i-1)}
\end{aligned}
$$

Redundant part

$$
s(i) = e^{j\Delta\theta_i}s(i-1) \quad \rightarrow \quad s(i)s^*(i-1) = e^{j\Delta\theta_i}|s(i-1)|^2 = e^{j\Delta\theta_i} \qquad (|s(i)|^2 = 1)
$$

Demodulation is possible even if there is a phase change in transmission line

Task

- build the DQPSK and non-coherent detector using C language
- measure BER with simulation
  - AWGN channel
    - ✓ Compare with theoretical result
    - ✓ Compare with coherent detection result
  - Apply random phase change to transmitted symbols
    - ✓ Compare with theoretical result
    - ✓ Compare with coherent detection result
- BER for DQPSK:

$$P_e \simeq \frac{1}{2}\text{erfc}\left\{2\sqrt{\gamma}\sin\left(\frac{\pi}{8}\right)\right\}$$

(γ is E_b/N_0(not dB))