Direction of Arrival Estimation
Interferometer

at least two sensors (e.g. antenna elements) required

plane wavefront

path length difference
\[ dL = d \cos(q) \]

\[ L_1 \] distance \( d \)

\[ \text{sensor 1} \]

phase shift
\[ 2\pi \frac{dL}{\lambda} = \beta dL = d \beta \cos(q) \]

- wavenumber \( \beta = \frac{2 \pi}{\lambda} \)
- sinusoidal received signals

\[ e_1(t) \sim \cos(\omega t) \]

\[ e_2(t) \sim \cos(\omega t + d \beta \cos(q)) \]
Considering $0 \leq \phi \leq \pi$ (due to the symmetry of the sensor array), there will be a one-to-one mapping between the observed phase drift and the direction of arrival if

$$\delta \beta \leq \pi$$
$$\delta \leq \frac{\pi}{\beta} = \frac{\pi}{\frac{\alpha}{2}}$$

(then the phase can be measured unambiguously as it will be between $-\pi$ and $+\pi$).

A promising approach, but needs further investigation:

- more than two sensors
- several sources with different directions of arrival
- low complexity signal processing algorithms
Applications

- mobile radio communications
- intelligence
- sonar
- seismology
- radar
- radio astronomy
4 receive antenna elements
2 transmit antenna elements

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