Stereo

Helmut Wittek, 2013
Real source vs. phantom source

or

2.3. About perception theory…
• A **phantom source** is a fictive sound source. It is perceived at a location where no actual sound source is.
• It is produced by min. two loudspeakers reproducing a **coherent** signal.
• The phantom source is perceived between the loudspeakers. It is shifted towards the direction of one of the loudspeakers by **level and/or time differences**.
Sound source $\rightarrow$ Phantom source

$\Delta t, \Delta L$ between microphones

$\Delta t, \Delta L$ between loudspeakers
The Recording angle

Phantom Source
The Recording angle
Phantom source shift by $\Delta L$ and $\Delta t$

Time difference $\Delta t$

Level difference $\Delta L$


2.2. Phantom source shift by $\Delta t/\Delta L$
Real source, 15° right

Phantom source, 15° right:
1: $\Delta L=7$ dB, $\Delta t=0$ ms
2: $\Delta L=3.5$ dB, $\Delta t=0.2$ ms
3: $\Delta L=0$ dB, $\Delta t=0.4$ ms
Phantom source shift by $\Delta t/\Delta L$

- A, B, C, D, E: different literature!

- A, B, C, D, E: different literature!
• **SCHOEPS Microphone Showroom:** [www.schoeps.de/showroom](http://www.schoeps.de/showroom)

offers an interactive comparison between various techniques and microphones...
• **AB, Decca Tree**
  – 2-3 * Omni (LF pickup !)
  – Distance: 0.5 .. 2 m (decorr!)
  – Most popular for orchestra recording
  – Vague directional image, open spatial image

• **ORTF, quasi-ORTF setups**
  – 2 cardioids (or var.)
  – Distance: 0.17 m, Angle: 110 ° (or var.)
  – Most popular for ensemble recording
  – Good directional image, good spatial image
  – low DFC
• **XY, MS setups**
  - 2 directional pattern or M (variable) + S (fig-8)
  - Distance: 0 m, Angle ≥ 90°
  - Most popular for film, music, drama recording
  - Good directional image, clear spatial image
  - DFC often high, strongly depend on the setup
Stereo microphones: XY
Stereo microphones: M/S

- CMC 64 + CCM 8
- RCY
- SGMSC (CCM4 + CCM8)
- CMIT MS
- UMS 20
- WSR MS
- MS-BLM
Stereo microphones: spaced setups

- Decca 3 * CCM 2H
- MSTC 64 U, STC
- IMS 20
- M100C
- KFM 6
- MAB1000
- ORTF Outdoor Set

Schoeps Mikrofone
5.1 Surround
• The reference: perception of a natural source
**Discrete** Signals:
- Correlated at both ears
- From discrete directions

**Diffuse** Signals:
- Decorrelated at both ears
- From all directions

**Spatial impression**
- Direction
- Distance, Depth, Spaciousness
- Envelopment
- Reverberance

**Temporal axis**
- 0 ms
- 30 ms
- t

© Theile
Early reflections

Imaging area

Reverb

Spatial reproduction by multichannel stereophony
Developing a 5.1 Multichannel Microphone setup:

Pair (L/C)  Pair (C/R)

Pair (L/LS)  Pair (LS/RS)  Pair (R/RS)
• Example: 5 cardioid (CCM 4) setup with windscreens:
• Calculation of Surround arrays:
• M. Williams: **MMAD**, MAGIC arrays, Critical Linking
  
  [http://www.mmad.info](http://www.mmad.info)
Developing a 5.1 Multichannel Microphone setup: OCT
OCT setup

\[ \alpha = 30^\circ \]

\[ \alpha = 0^\circ \]

\[ \alpha = 90^\circ \]
OCT Surround using 5 SCHOEPS CCM compact microphones and the stereo bar MAB1000
OCT Technique:

- Imaging area
- Early reflections
- Reverb

Diagram:

- L, C, R, LS, RS
- h
- b
- b + 20 cm
- 40 cm
OCT + Hamasaki square

Early reflections
Reverb

L
h
C
b
R

L
> 2 m

R

> 2 m

LS
RS

2.6. Spatial
Surround main microphones: Double M/S

Double - M/S

free Plug-in and Audio Samples online:
www.schoeps.de/dmsplugin.htm
Double MS: The M/S principle

\[
\begin{align*}
M &= L + R \\
S &= L - R
\end{align*}
\]

\[
\begin{align*}
L &= \frac{1}{2} \times (M + S) \\
R &= \frac{1}{2} \times (M - S)
\end{align*}
\]
Double MS: The M/S principle

- Front M/S pair
- Rear M/S pair
- Combined Double M/S triplet
2.8. Surround main microphones: Double M/S

- Double M/S with shotgun
Decoding variants:
- 2 M/S Matrices
- Hardware (M DMS)
- Free Software (VST, RTAS)

www.schoeps.de/dmsplugin.htm

DEMO Sound Sample #9
Schostakovitsch
Klavierkonzert

DEMO Sound Sample #10
Schalke
Volksmusik
Rossini

Drums

2.8. Surround main microphones: Double M/S
Ambience techniques for Stereo 2.0 and 5.1

Helmut Wittek, September 2013
www.hauptmikrofon.de
• **Ambience**: how do you record it?
  - The 3 ambience layers
  - Microphone placement for the 3 ambience layers
  - Making decisions:
    Layer mix, tonmeister taste and practical requirements
  - Microphone techniques
    - M/S, X/Y, ORTF, A/B, Double M/S, Double M/S with Shotgun, IRT-Cross, ORTF Surround, Theile trapezoid, Hamasaki Square, 5 cardioids, Decca-Tree, …
**Discrete** Signals:
- Correlated at both ears
- From discrete directions

**Diffuse** Signals:
- Decorrelated at both ears
- From all directions

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**Spatial reproduction**
What is ambience?

Signal type

1. **Reverb**
   - diffuse
   - location-independent
   - not localized
   - Room information

2. **Early Reflections**
   - discrete
   - location-independent
   - localized, but the location is arbitrary
   - Info on position of the source in the room

3. **Discrete Sources**
   - discrete
   - location-dependent
   - localized
   - Source information

Room signal properties
Microphone geometry for recording diffuse sound:

- Uncorrelated signals
- Balanced energy distribution

Diffuse sound in the recording room $\rightarrow$ diffuse sound in the reproduction room

Ambience components: diffuse sound
Microphone geometry for recording diffuse sound:

- Uncorrelated signals
- Balanced energy distribution

Diffuse sound in the recording room → diffuse sound in the reproduction room
Microphone geometry for recording diffuse sound:

- Uncorrelated signals
- Balanced energy distribution

Diffuse sound in the recording room $\rightarrow$ diffuse sound in the reproduction room

$\rightarrow$ Each channel records a different diffuse signal

$\rightarrow$ The channels are decorrelated regarding the diffuse field
Ambience components: diffuse sound

Microphone geometry for recording diffuse sound:

- The larger the distance, the more independent the signals

- The larger the directivity, the more independent the signals

- The larger the opening angle, the more independent the signals
Diffuse field correlation (DFC)

- is dependent on the distance, angle and directivity
- is dependent on the frequency (wave length)

<table>
<thead>
<tr>
<th>Setup</th>
<th>XY, 90°, Cardioids</th>
<th>XY, 120°, Super-cardioids</th>
<th>Blumlein, 90°, Figure-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFC</td>
<td>0.75</td>
<td>0.23</td>
<td>0</td>
</tr>
</tbody>
</table>

Ambience components: diffuse sound
Diffuse field correlation (DFC): coincident setups

Ambience components: diffuse sound
Diffuse field correlation (DFC)

from: [Riekehof et al., TMT 2010]

Ambience components: diffuse sound
<table>
<thead>
<tr>
<th>Signal type</th>
<th>Microphone signal properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Reverb</td>
<td>• Uncorrelated signals</td>
</tr>
<tr>
<td></td>
<td>• Balanced energy distribution</td>
</tr>
<tr>
<td>2 Early Reflections</td>
<td>• Correlated signals</td>
</tr>
<tr>
<td></td>
<td>• Balanced directional distribution</td>
</tr>
<tr>
<td>3 Discrete Sources</td>
<td>• Correlated signals</td>
</tr>
<tr>
<td></td>
<td>• Balanced directional distribution</td>
</tr>
<tr>
<td></td>
<td>• Real or realistic directional imaging</td>
</tr>
</tbody>
</table>

**What is ambience?**
### Choice of the setup: 3 Steps

**Step 1. Ambience layer mix: what is my ambience composed of?**

<table>
<thead>
<tr>
<th>Diffuse Layer</th>
<th>Reflection Layer</th>
<th>Direct sound layer</th>
<th>Example</th>
<th>Possible microphone setup for 5.1 Surround</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>- (with Center)</td>
<td>Film ambience without discrete noise</td>
<td>5 Omnis</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>- (without Center)</td>
<td>Concert hall ambience</td>
<td>Hamasaki Square</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X (without Center)</td>
<td>Stadium ambience for Sports</td>
<td>ORTF Surround</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X (with Center)</td>
<td>Documentary ambience with discrete sources</td>
<td>5 wide cardioids</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X (3 only in front)</td>
<td>Orchestra in the concert hall</td>
<td>OCT Surround, OCT + Hamasaki</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Dry outside ambience</td>
<td>Double M/S, ORTF Surround</td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td>Dry radio drama recording in the studio</td>
<td>Double M/S</td>
</tr>
</tbody>
</table>
Choice of the setup: 3 Steps

Step 2. The individual taste of the tonmeister and his priorities:
- Choice of the **directivity pattern** and the **microphone type**
- Relative weight of **sound colour, depth, immersion, room impression, directional imaging, naturalness, stability**, etc.

Step 3. Practical Aspects
- **Size, suspension, windshield, flexibility, ease of use, simplicity, price, postpro-options**, etc.
Ambience microphones for Stereo

A/B

ORTF

Coincident

Decca Tree

A/B/C
Ambience microphones for Surround

IRT Cross

MMAD/INA/OCT/Equivalence

Hamasaki Square

Decca Tree

ORTF Surround

Coincident
Double M/S

- Compact, flexible and practical
- Only 3 channels for Surround
- Decoding with 2 * M/S-Matrix, Hardware decoder or Plug-in
- High DFC if more than 3 output channels are used; maximum 4 Outputs are feasible
- If decoded properly:
  - Average room properties
  - Good sound colour; good imaging properties

Ambience microphones for Surround
Double M/S with shotgun

- Using a shotgun for the Centre channel: ideal setup for documentary
- Compact: Surround setup with windshield not larger than for Mono
- Flexible and practical
- If decoded properly, good spatial properties
- Only 3 channels for Surround: shotgun, Fig-8, Cardioid
- Simple decoding with 2 normal M/S-Matrices

Ambience microphones for Surround
IRT Cross

- Open room sound, very good 360°-Imaging
- Basis spacing:
  - 4 cardioids: 25cm
  - 4 supercardioids: 18cm
  - 4 wide cardioids: 31cm

Ambience microphones for Surround
• IRT Cross: Application

2.6. Spatial reproduction by multichannel stereophony
• IRT cross for Surround atmos:
  – 4 Cardioids at 20 cm - 90°
  – 4 Supercardioids at 14 cm - 90°
• “ORTF Surround” for Surround atmos:
  – 4 Supercardioids at 10/20 cm - 100°/80°
2.6. Spatial reproduction by multichannel stereophony

- IRT cross for Surround atmos
  - 4 Cardioids at 20 cm - 90°
  - 4 Supercardioids at 14 cm - 90°

- “ORTF Surround” for Surround atmos
  - 4 Supercardioids at 10/20 cm - 100°/80°
2.6. Spatial reproduction by multichannel stereophony

- **IRT cross for Surround atmos**
  - 4 Cardioids at 20 cm - 90°
  - 4 Supercardioids at 14 cm - 90°

- **“ORTF Surround” for Surround atmos**
  - 4 Supercardioids at 10/20 cm - 100°/80°
• ORTF Surround below the stadium roof
1. Main mic:
   ORTF Surround

2. Stereo spots:
   ORTF Stereo

3. „Close-Ball“:
   SuperCMIT

4. Mono spots:
   Single CCM
ORTF Surround

- 4 Supercardioids, 10cm/100° + 20cm/80°
- Compact and practical
- Open room sound + ideal 360°-Imaging (same as the IRT cross)
- **Plug&Play:** special windshield, suspension, Multicore mit Multipin-Plug
Theile trapezoid

- Room microphone for Front-Back-Scenario; not for Layer 3, ideal for layers 1 und 2
- 4 cardioids, facing backwards; d = 60 cm
- Optimal attenuation of direct sound from 0°
Theile trapezoid

Photos: R. Bihler, SWR

Ambience microphones for Surround
Hamasaki Square

- Room microphone; not suitable for Layer 3-Signals, ideal for Layer 1 and Layer 2
- Extremely large spacing, not handy
- Open room sound, extremely low DFC
- Large attenuation of direct sound from 0°!
- Optimal reproduction of early lateral reflections

DFC = 0!

Figures for the pair L/Ls; d=200 cm

Ambience microphones for Surround
5ch – Equivalence setup after Williams/Theile/Wittek

- With Centre channel
- Geometry is calculated after e.g. Williams MMAD, INA or „Image Assistant“
- With normal, open or wide cardioids
- Very good sound colour
- Very good room and imaging properties
- Not compact; needs large spacings and single windshields

Stabile 360° Abbildung, toller Klang

Figures for „INA 3“
5ch – Equivalence setup after Williams/Theile/Wittek

Williams „Umbrella“: flexible suspension
OCT Surround

- Ideal for Front-Back-Scene (Layer 3 only in front)
- Very natural room and imaging properties
- Not compact
- Good sound colour
- Optimal attenuation of Crosstalk $\rightarrow$ large stability of the image
- More Flexible: OCT + Hamasaki Square

Figures for the pair L/C and C/R
OCT Surround

Ambience microphones for Surround
Omni setup

- Very large, not compact
- Uses Omnis → often preferred sound colour
- Very good room properties
- Average imaging properties, yet stable

Ambience microphones for Surround
Practice: Sports

Soccer: ORTF in the curve

Soccer World Cup: Double M/S and ORTF Surround
Practice: Film

Double M/S with shotgun (A. Zacher)
IRT Cross

5 wide cardioids (F. Camerer)

„Sound only“ with M/S

Ambience microphones for Surround: Examples
VDT Seminar ATMO(Ambience)

- ambience.hauptmikrofon.de
- 5 * 6 Audio samples for Download
- Listening test can be performed
- Descriptions of the setups
- Download of all Seminar talks and videos

- Thank you very much!
- wittek@schoeps.de