

Surround Sound

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Initial Terms

- * Monaural - listening through one ear
- * Binaural - listening through two ears
- * Binaural Recording - realistic stereo image (to be discussed later)
- * Monophonic - reproduction through a single channel
- * Stereophonic - originally meant three-dimensional, now used to mean two channel sound recording and reproduction
- * Multichannel - generally refers to systems with a higher channel number.

Multichannel

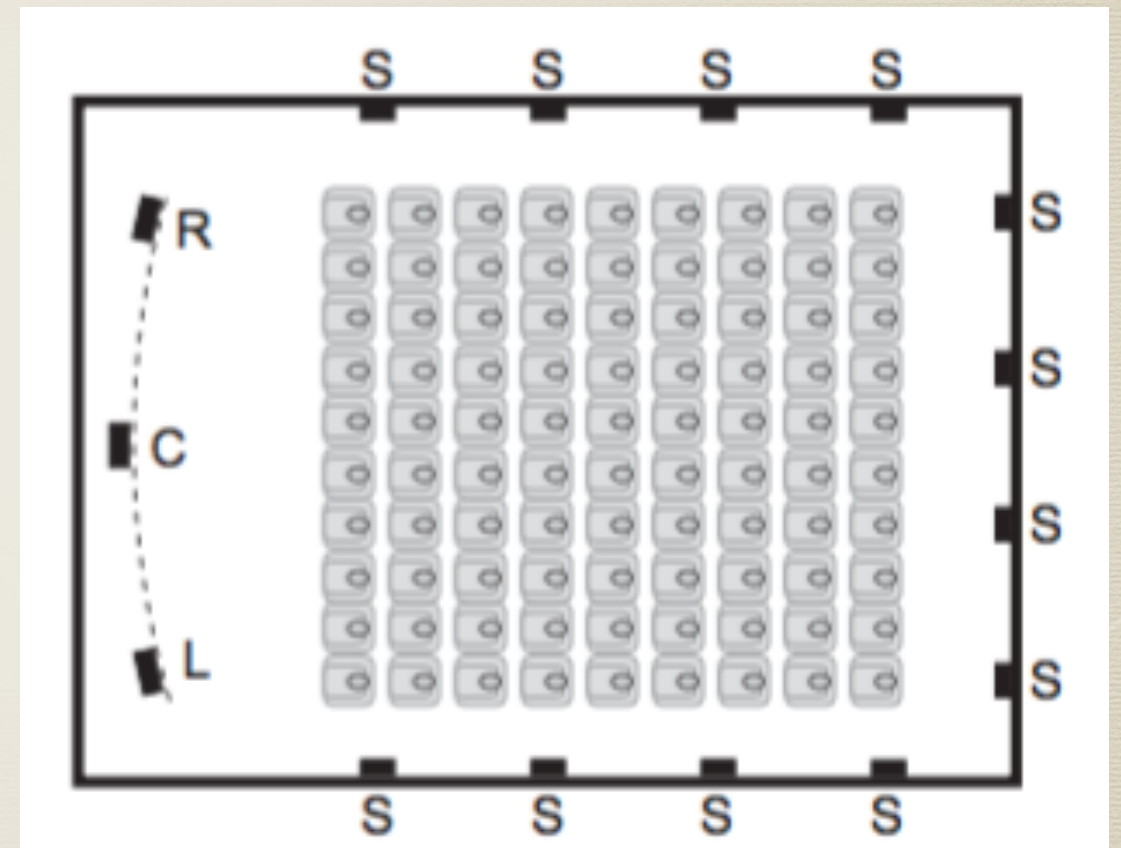
- * Monophonic reproduction conveys most of the musically important dimensions: melody, harmony, timbre, tempo, and reverberation, but no sense sound- stage width, depth, or spatial envelopment—of being there. In the 1930s, the essential principles by which the missing directional and spatial elements could be communicated were understood, but there were technical and cost limitations to what was practical.
- * Blumlein-EMI patent (Blumlein, 1933), applied for in 1931, described two- channel stereo techniques that would wait 25 years before being popularised.
- * The motivation for stereo came in part from a desire to improve cinema sound.
- * Steinberg and Snow (1934) at the Bell Telephone Laboratories who, when considering the reproduction of auditory perspective, concluded there were two alternative reproduction methods that would work: binaural and multichannel.
- * Multichannel reproduction is where each channel with its associated loudspeaker creates an independently localisable sound source, and interactions between multiple loudspeakers create opportunities for “phantom” sources.

Multichannel

- * “How many channels are necessary?”
- * Bell Labs scientists assumed that a great many channels would be necessary to capture and reproduce the directional and spatial complexities of a musical front soundstage—not even attempting to recreate a surrounding sense of envelopment.
- * Steinberg and Snow concluded that although two channels could yield acceptable results for a solitary listener, three channels (left, center, and right) would be a workable minimum to establish the illusion of a stable front soundstage for a group of listeners.

Audio-Cinema

- * Dolby stereo as it was developed in 1976: three channels across the front and a single surround channel delivered identically to loudspeakers surrounding the audience. This is the foundation from which the home theater and multichannel music technologies we know today evolved.



3.0

- * L-C-R - 3 channel stereo
- * 1. Front Left
- * 2. Front Right
- * 3. Centre
- * Centre channel anchors so that left and right can be spread wider if desired.

Source:

Rumsey, F. & McCormick, T. (2009) Sound and Recording. Focal Press.

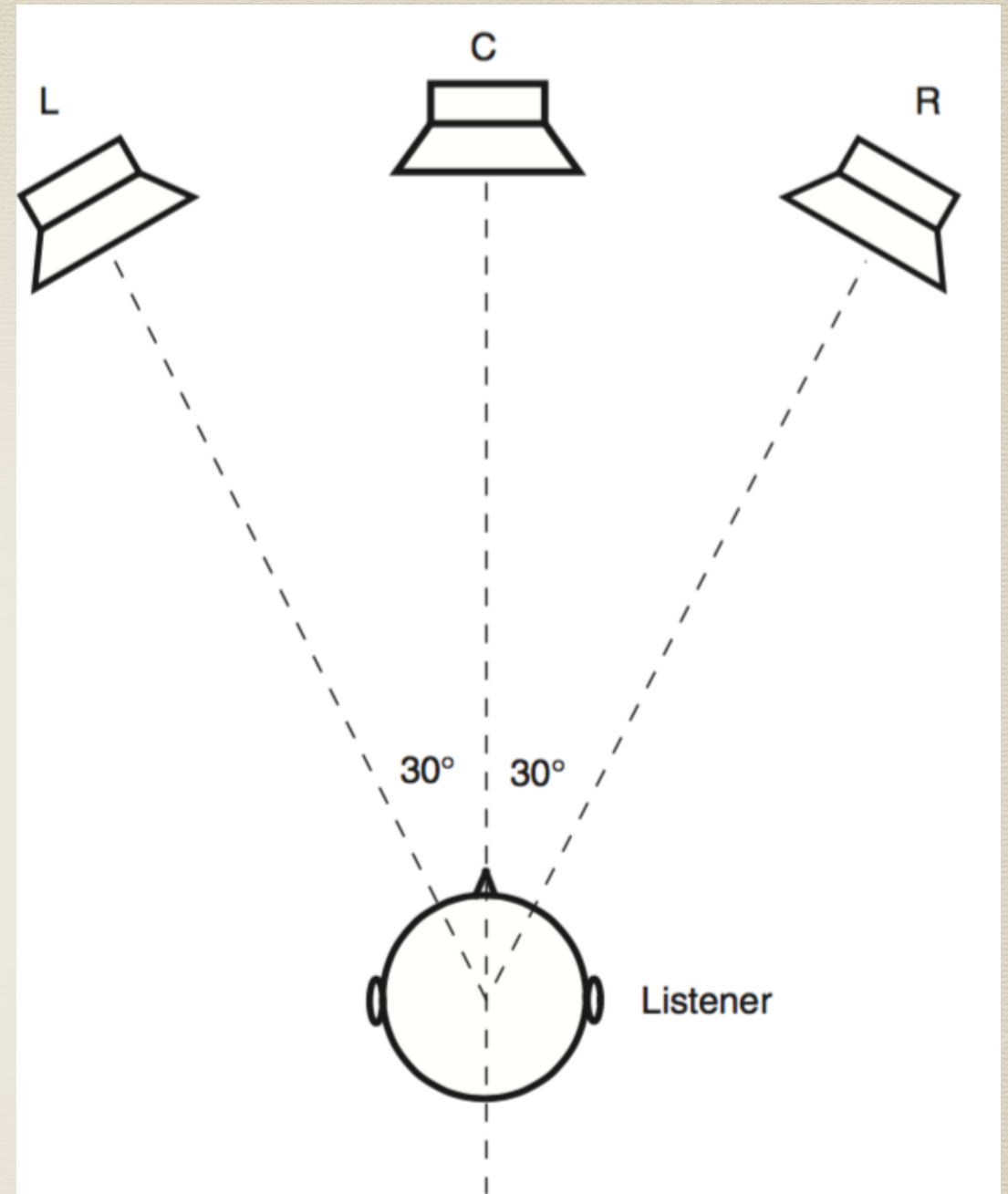


FIGURE 17.1 Three-channel stereo reproduction usually involves three equally spaced loudspeakers in front of the listener. The angle between the outer loudspeakers is 60° in the ITU standard configuration, for compatibility with two-channel reproduction, but the existence of a center loudspeaker makes wider spacings feasible if compatibility is sacrificed.

3.1 - LCRS Surround

- * an additional 'effects' channel or 'surround' channel is added to the three front channels, routed to a loudspeaker or loudspeakers located behind (and possibly to the sides) of listeners.

4.0 - Quadrophonic

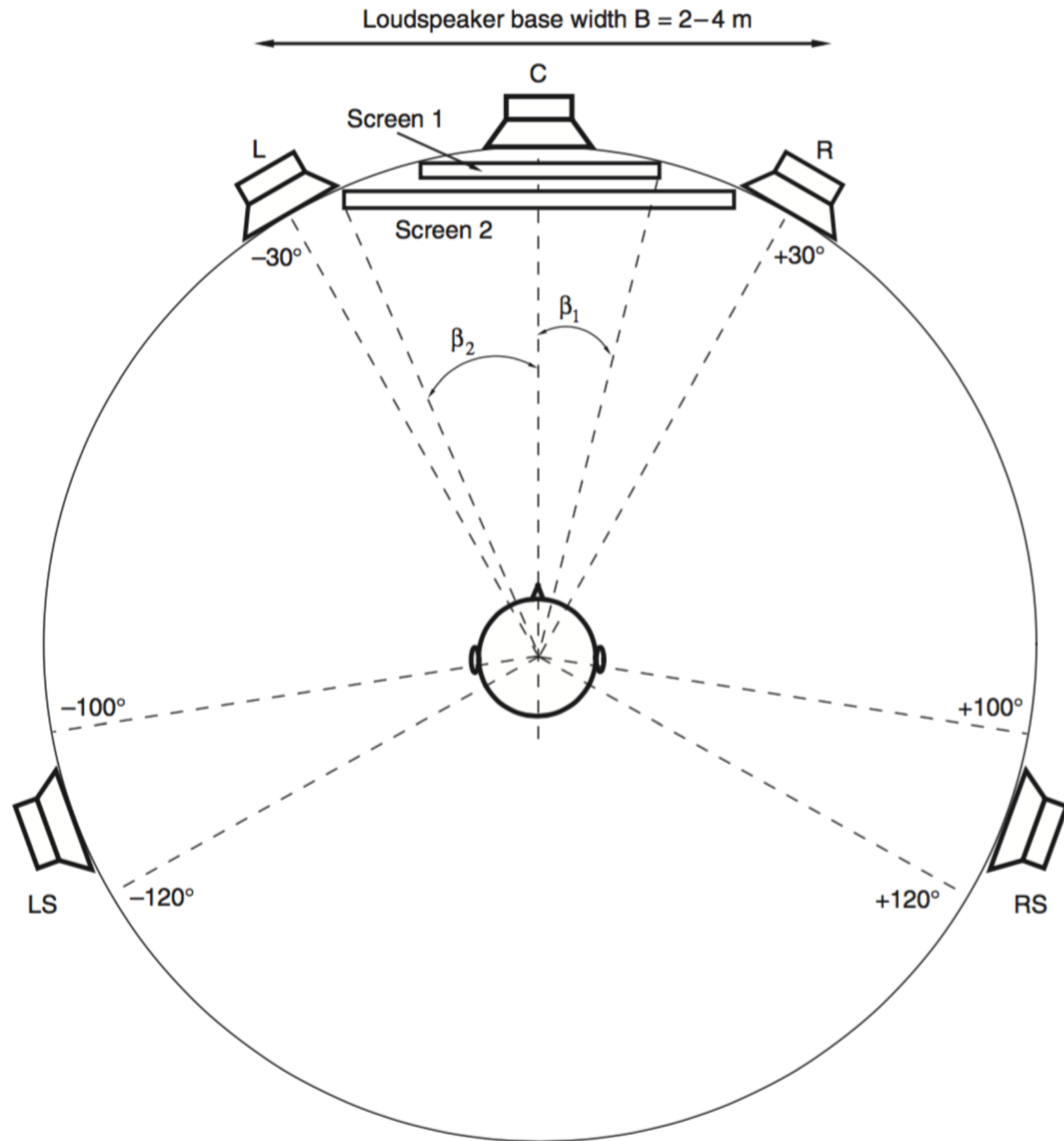
- * speakers in 4 corners of the listening space
- * L, R, Ls, Rs
- * Everything Quad - <https://www.quadraphonicquad.com/forums/index.php>
- * Quad took off in the 1970s.

5.1

- * L, C, R, Ls, Rs, LFE
- * has been standardised for many surround sound systems, including cinema and home theatre systems
- * purpose was to include room ambience to accompany a primarily front-orientated sound stage.
- * the front three channels are intended to be used for a conventional three-channel stereo sound image, whilst the rear/side channels are only intended for generating supporting ambience.
- * the standard does not directly support the concept of 360° image localisation, although it may be possible to arrive at recording techniques or signal processing methods that achieve this to a degree.

FIGURE 17.3

3-2 format reproduction according to the ITU-R BS.775 standard uses two independent surround channels routed to one or more loudspeakers per channel.



Screen 1: Listening distance = $3H$ ($2\beta_1 = 33^\circ$) (possibly more suitable for TV screen)

Screen 2: Listening distance = $2H$ ($2\beta_2 = 48^\circ$) (more suitable for projection screen)

H: Screen height

LFE

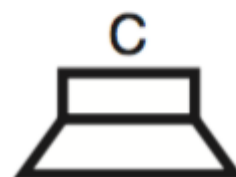
- * Low Frequency Enhancement
- * The low-frequency effects channel is a separate sub-bass channel with an upper limit extending to a maximum of 120Hz. It is intended for conveying special low-frequency content that requires greater sound pressure levels and headroom than can be handled by the main channels. It is not intended for conveying the low-frequency component of the main channel signals, and its application is likely to be primarily in sound-for-picture applications where explosions and other high-level rumbling noises are commonplace, although it may be used in other circumstances.
- * In consumer audio systems, reproduction of the LFE channel is considered optional. Because of this, recordings should normally be made so that they sound satisfactory even if the LFE channel is not reproduced.

7.1

- * 7.1 adds two front speakers to the 5.1
- * L, LC, C, RC, R, Ls, Rs

Lexicon Logic 7

- * There were many competing standards, including Dolby Surround.
- * Lexicon Logic 7 enabled a more enveloping image and may enable rear loudspeakers to be placed further to the rear.



Additional side
speaker



Additional side
speaker

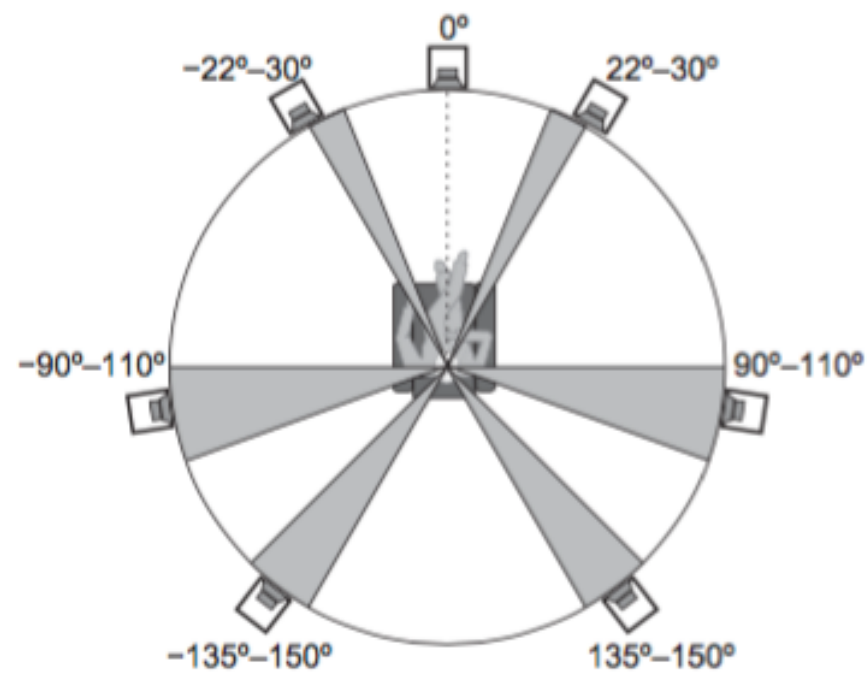


Listener

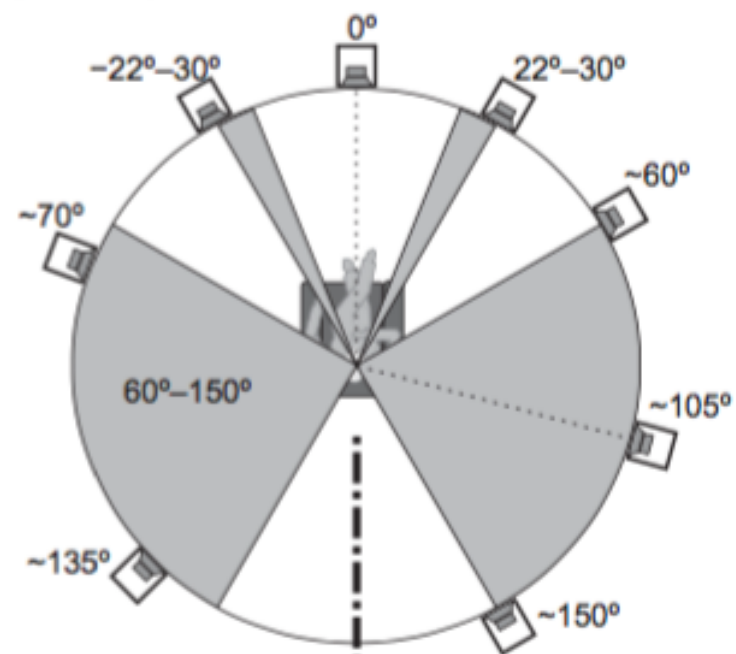
Rear speakers



(a) The Dolby recommendation



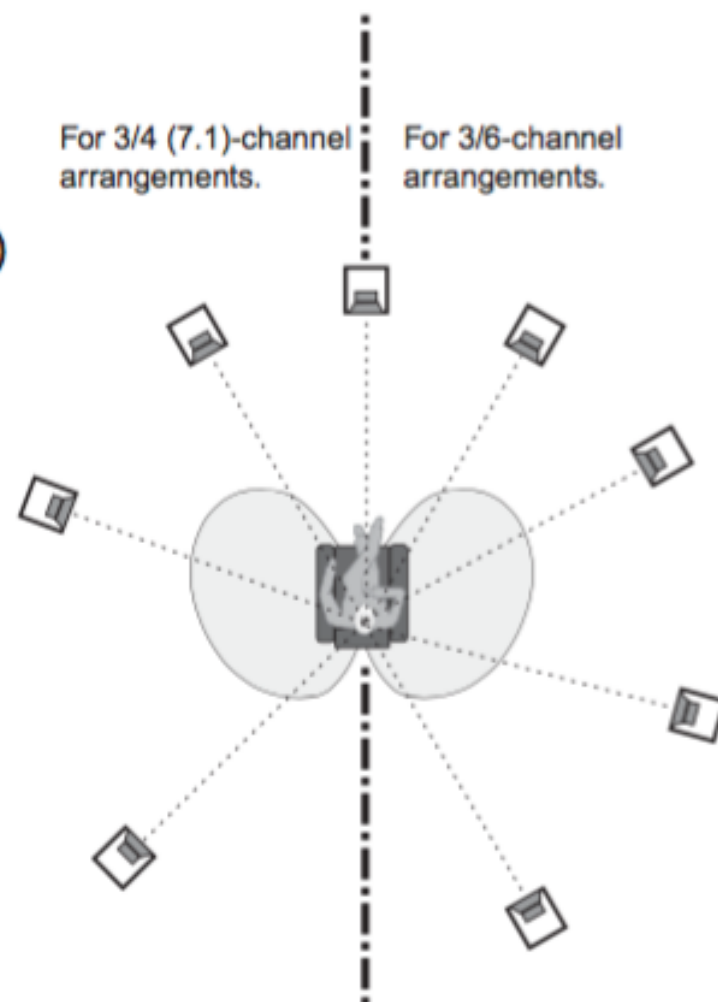
(b) A composite recommendation



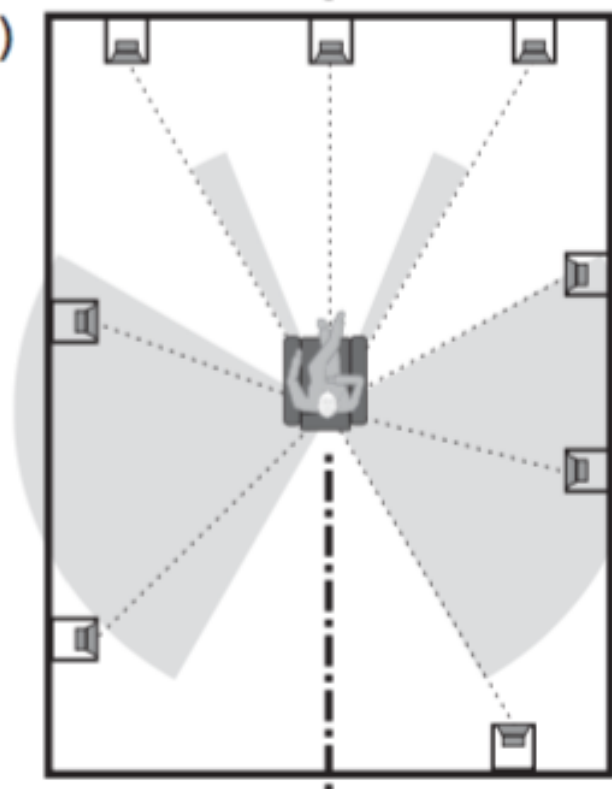
For 3/4 (7.1)-channel arrangements.
NOTE: side/rear channels should be decorrelated, e.g., by delays (a feature of 7.1-channel processors).

For 3/6-channel arrangements.
NOTE: additional side/rear channels should be decorrelated, e.g., by added delays.

(c)



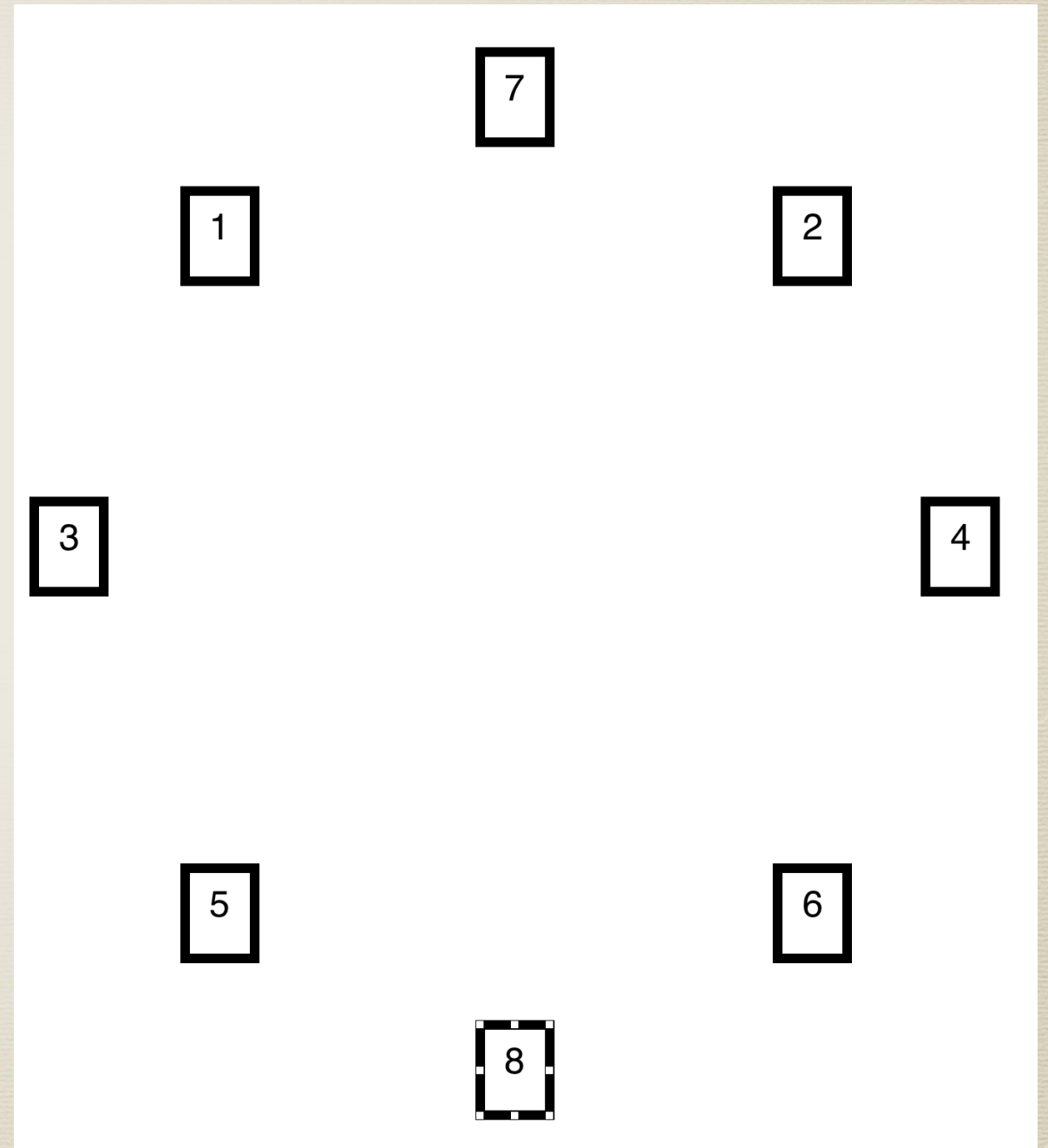
(d)



- * (a) The 7.1-channel recommendations from Dolby.
- * (b) The author's composite of the Dolby angular range for front left and right loudspeakers, the ITU angular range for 3/4, and higher-order surround configurations.
- * (c) A superimposition of the "spatial-effect balloon" from Chapter 7, showing that all of the loudspeakers are well positioned to create the desired impressions.
- * (d) One way that the recommendations may translate to a rectangular home theater installation. (b), (c), and (d) are divided left and right to show arrangements for 3/4 and 3/6 multichannel configurations.

Octophonic

- * Octo with Centre-Front - Diamond.
- * Channel order in pairs
- * Less focus on front facing speakers
- * More immersive



BEAST

- * Birmingham Electroacoustic Sound Theatre
- * <http://www.beast.bham.ac.uk/>

SARC

- * Sonic Art Research Centre
- * <http://www.sarc.qub.ac.uk/>

Dolby Digital AC-3

- * AC-3 encoding was developed as a means of delivering 5.1-channel surround to cinemas or the home without the need for analog matrix encoding.
- * Others to research:
 - * DTS
 - * SDDS
 - * MPEG Surround Modes

Rainbow Books

- * Red Book - CDDA
- * Scarlet Book - SACD - supports surround sound

5.1 recording

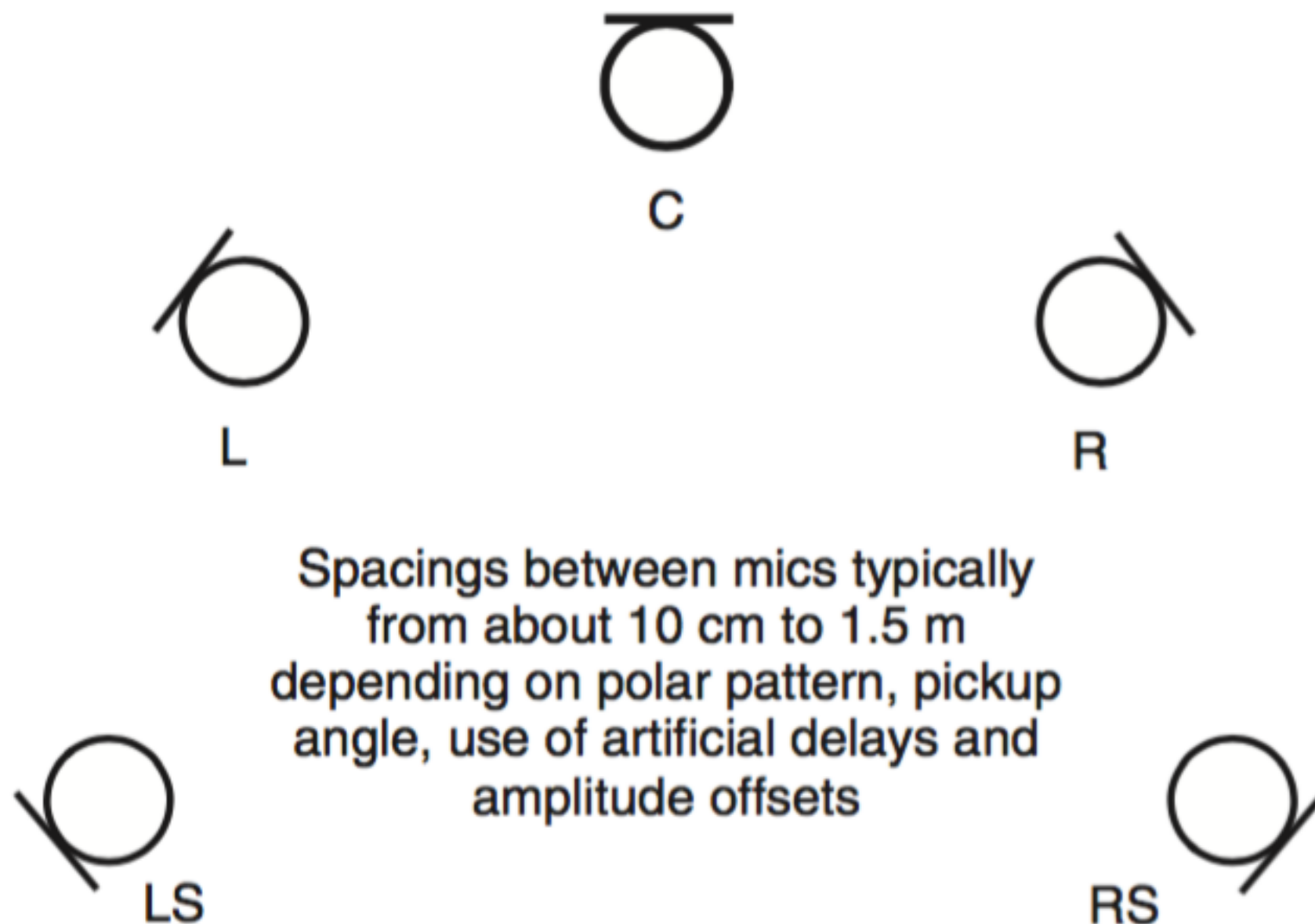


FIGURE 17.18 *Generic layout of five-channel microphone arrays based on time–amplitude trading.*

5.1 recording

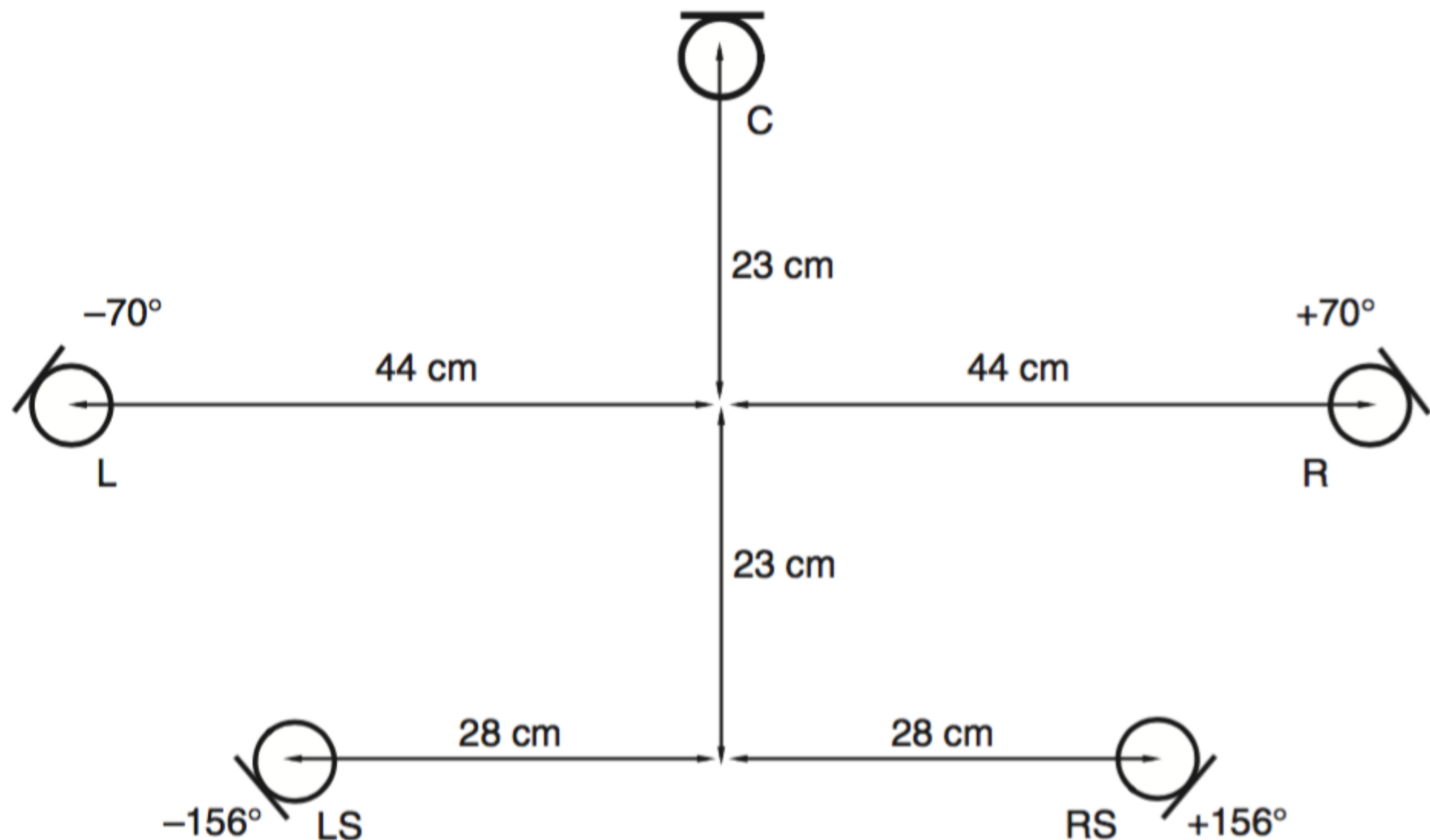


FIGURE 17.19 Five-channel microphone array using cardioids, one of a family of arrays designed by Williams and Le Dû. In this example the front triplet should be attenuated 2.4 dB with respect to the rear pair.

Recording Methods to Research

- * Decca Tree *
- * Fukada Tree
- * OCT-Surround *
- * IRT Cross *
- * Hamasaki Square