# MUS302 WEEK 10:
# SPACE IN MUSIC REVISITED

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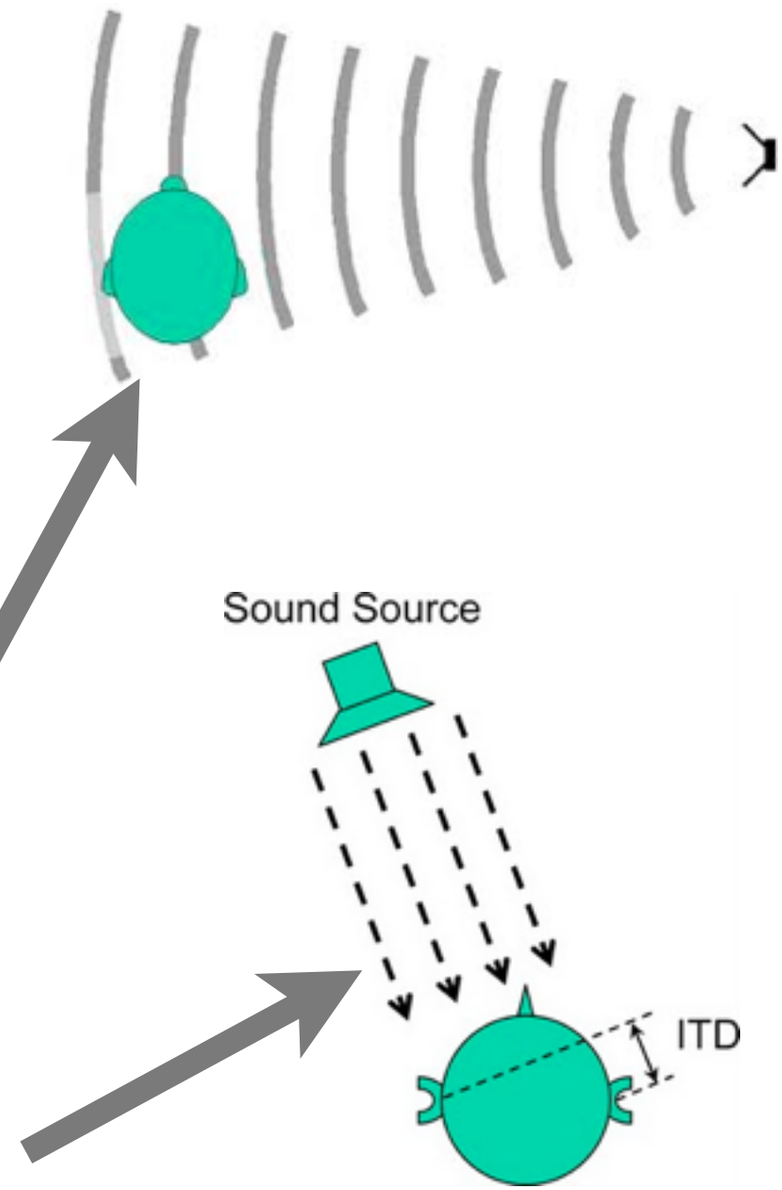
# RECAP: HEARING SOUND IN SPACE: BASIC LOCALISATION CUES

- We have the ability to **hear the horizontal direction of a sound due to the fact that we have two ears**
- **We compare (A) the level and (B) the arrival time for sound sources at  our two ears**
- We use these differences in the signal to decode direction
- **If the signal is near-identical at both ears**, we understand that the **sound is coming from straight ahead** (or straight behind)
- **If there is a difference in sound level, we assume that the sound is coming from the side at which it is loudest** (this is the most common stereo cue used in audio production)
- **If there is a difference in arrival time** between the different sound waves at the two ears, we assume that **the sound is coming from the side which detects the sound event first**



# RECAP: CONTRASTING SOUNDS, BIG DIFFERENCES

- Short and long sounds have very different spatial effects
- Short: we hear the full articulation of a note repeated…we often have noisy transient elements in sounds => easier to hear direction… (we will find out exactly why in a moment)
- Long sounds in music: tones/drones…we focus on the sustain portion, we hear the harmonic texture, we don't focus on how the sound started (attack transient) => harder to hear direction (we will find out exactly why in a moment)

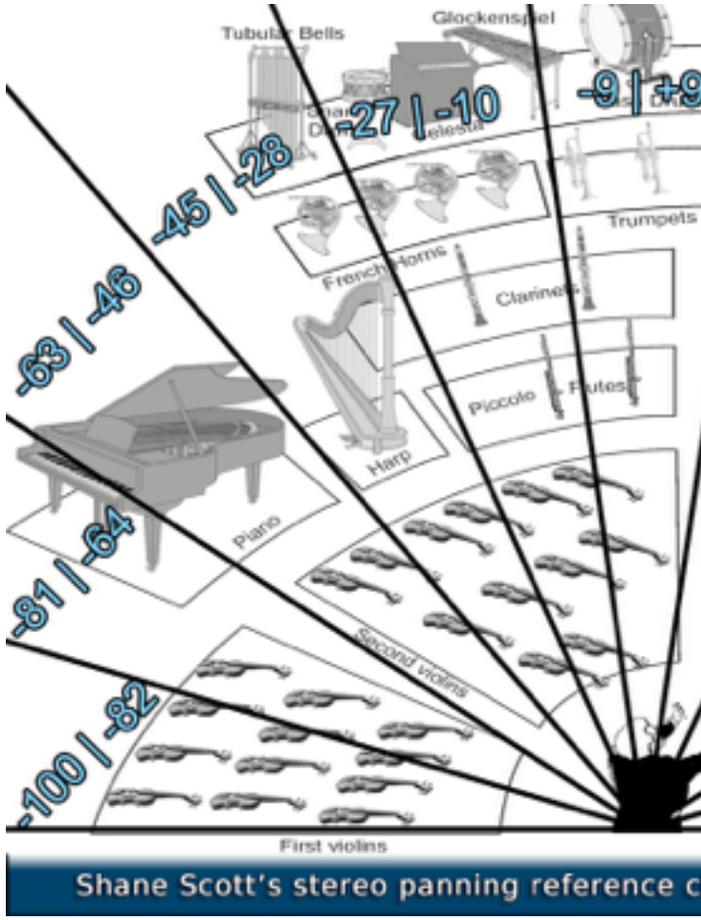
# RECAP: WHY ARRANGE MUSIC SPATIALLY?

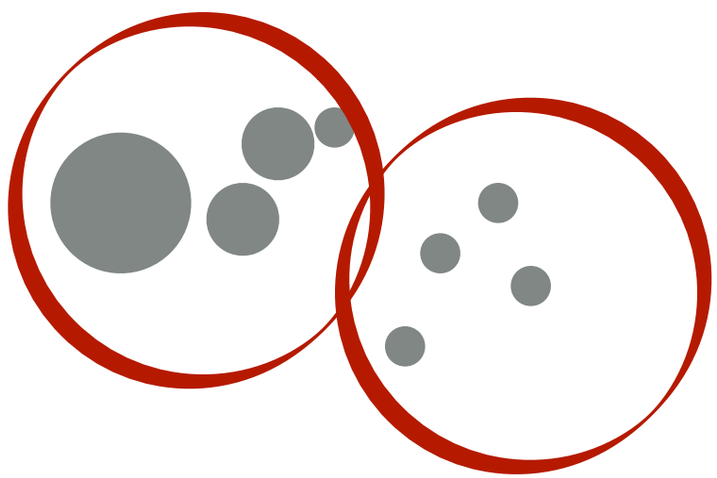
- **Why is any of this important for music?** Do we really need to move sounds in space: is it just a gratuitous special effect? Should music/sound really be spatial? Why do we want sounds to surround us?

- **Why do we place different musical instruments/sound sources in different apparent spatial locations?** What are we trying to achieve? What can it help us with?

- **How does this relate to musical structure?** (Do different melodic notes mean different spatial locations? why/why not?)

- **How does this relate to the structure of our wider sonic environment?** (What happens to our perception when sounds occur close together in space?)

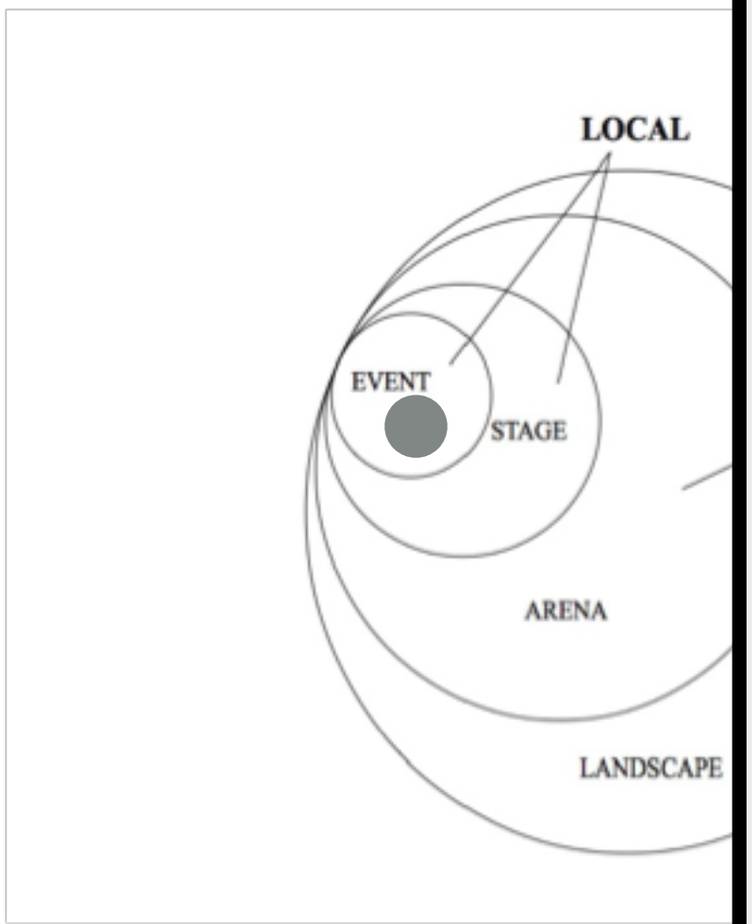


# SPACES AND FRAMES

Space in music isn't just about co-ordinates

we don't have *that clear* a spatial sense...=> it's more about relationships and zones/frames




Simon **Emmerson** has

written about **performance 'space frames'**

in his book *Living Electronic Music...*

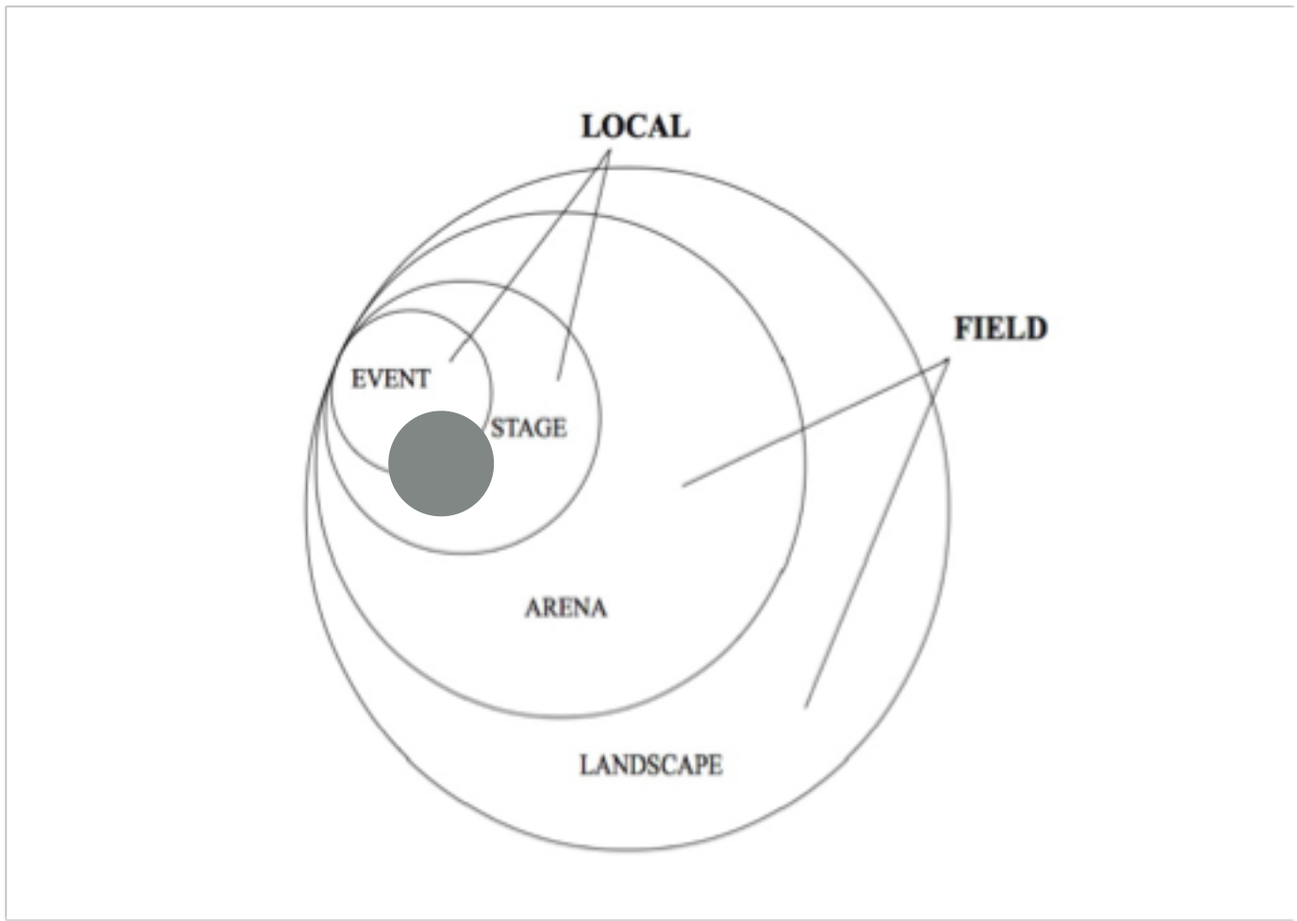
but **space frames are also important for composition**

(composition could be viewed as 'non-realtime performance')

# SPACES AND FRAMES

how do these frames relate to our perceptual experience?

how do different types of musical sources relate to the different frames?




Space frames (Emerson, 2007)

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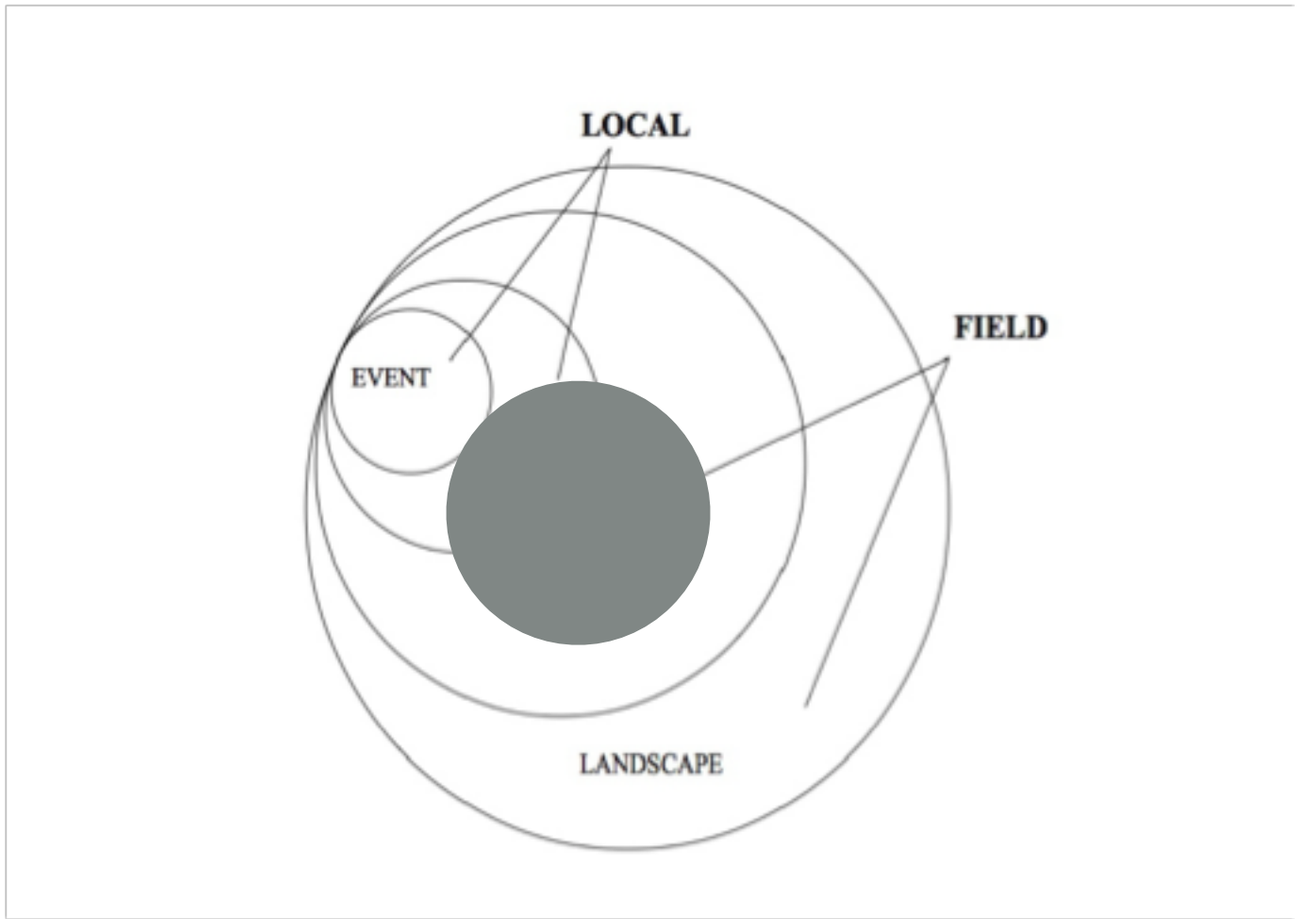


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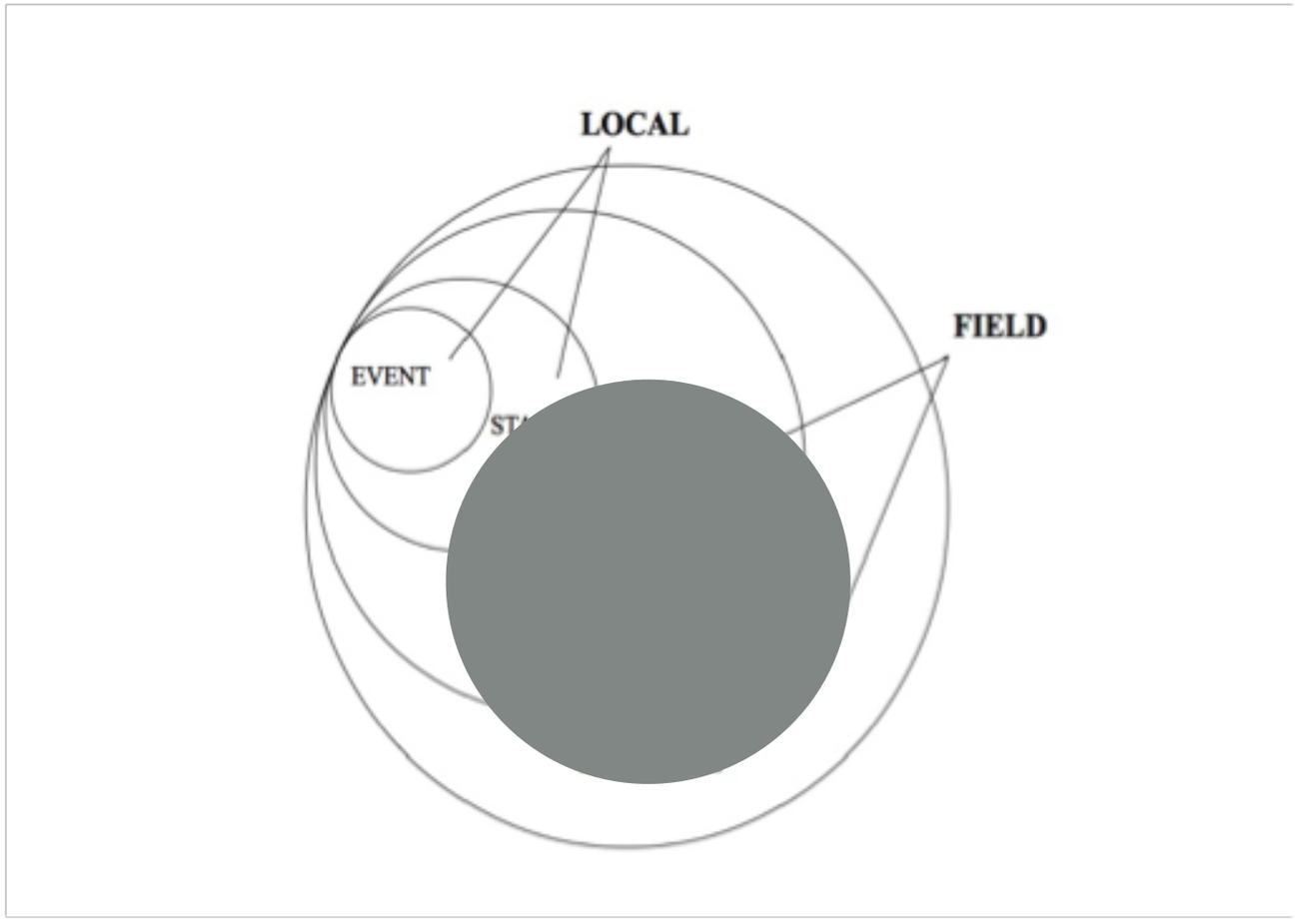


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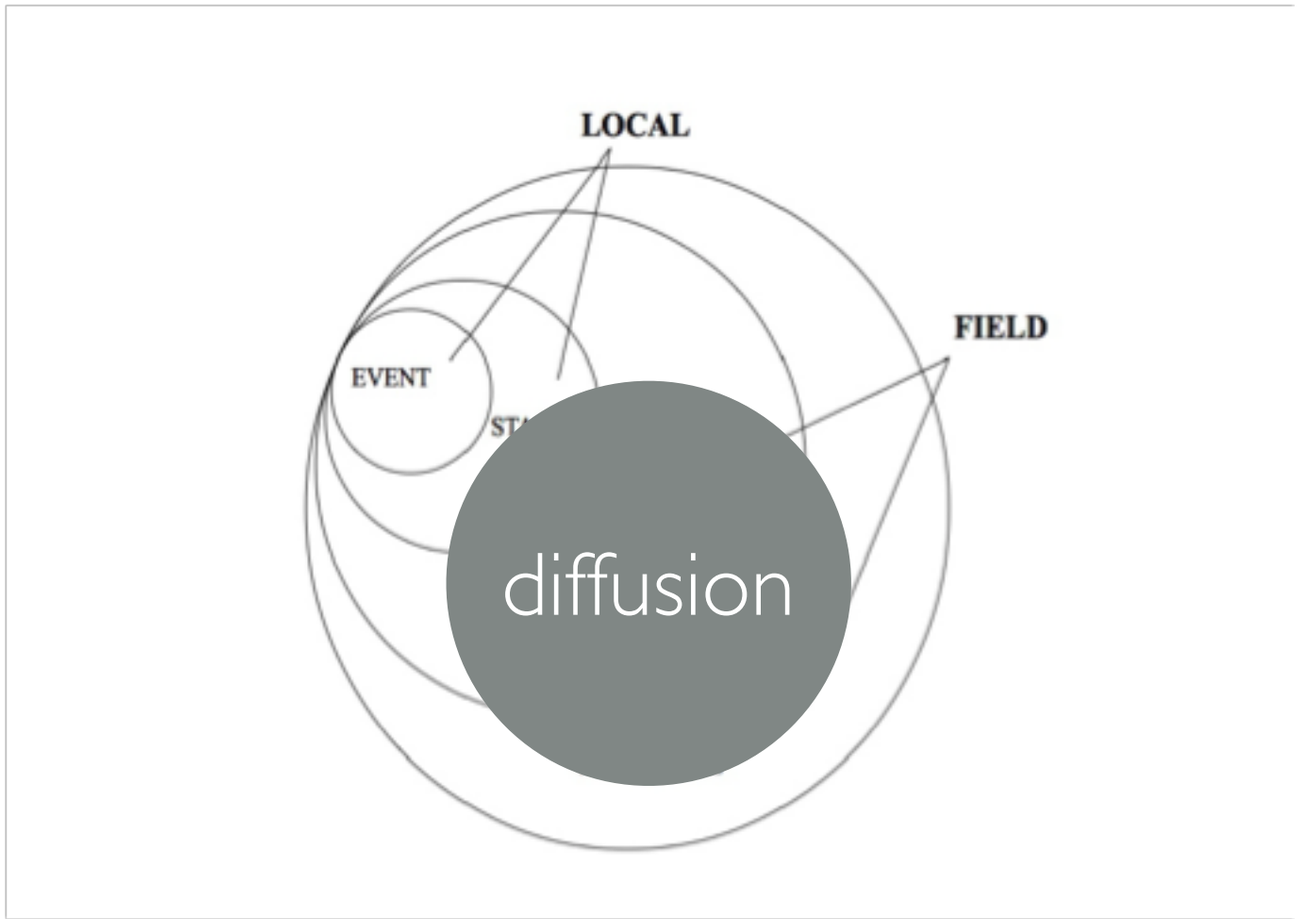


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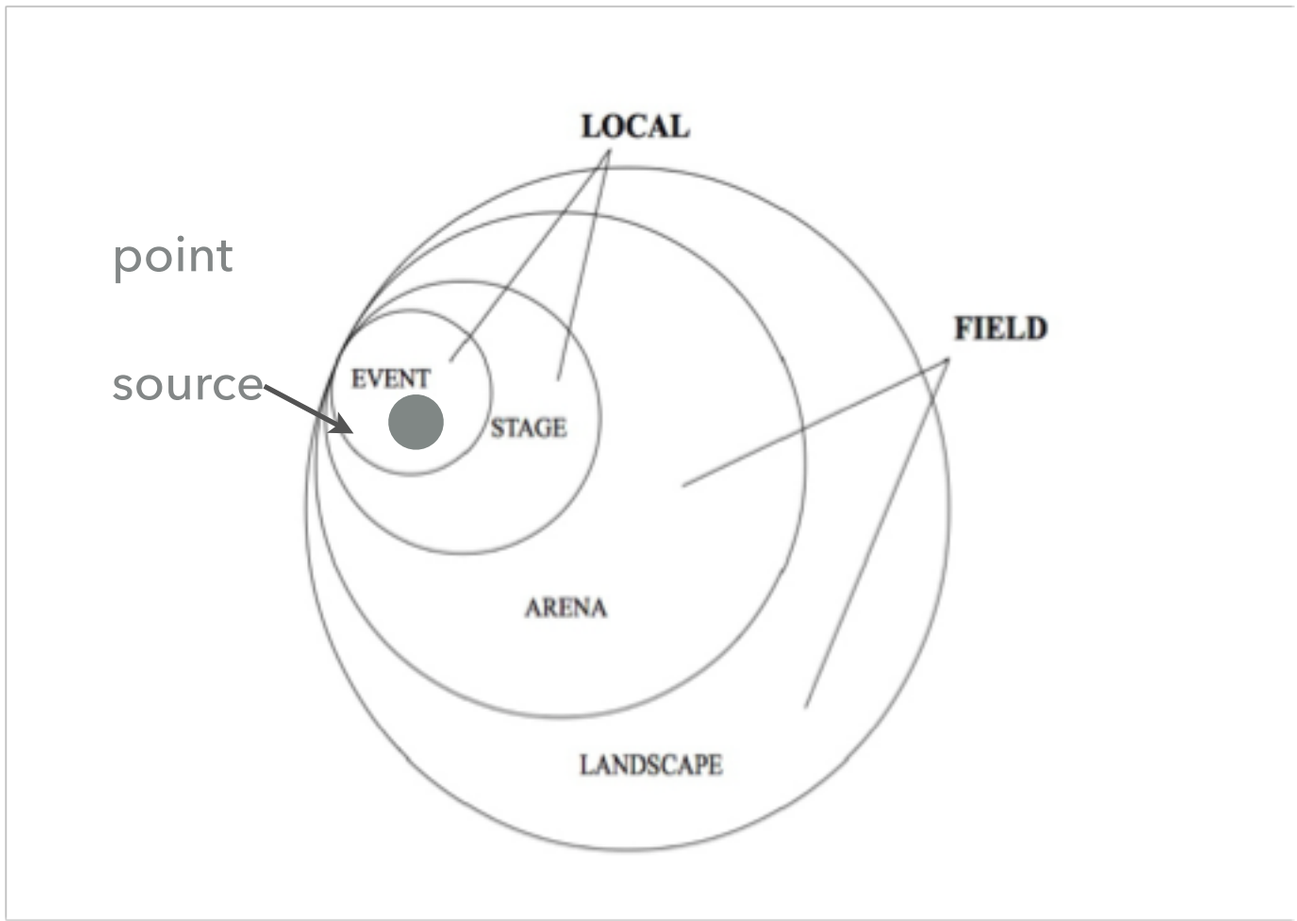


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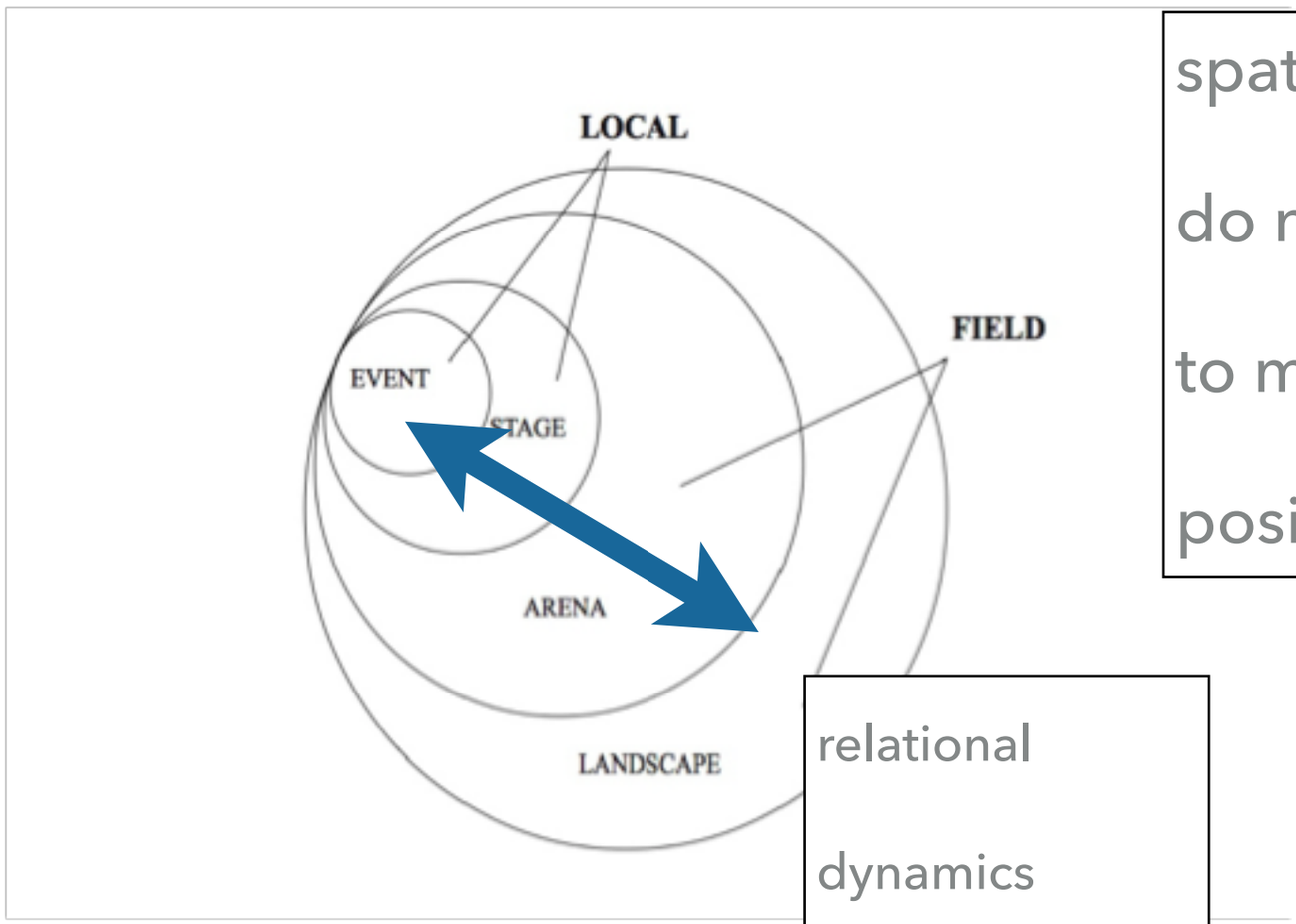


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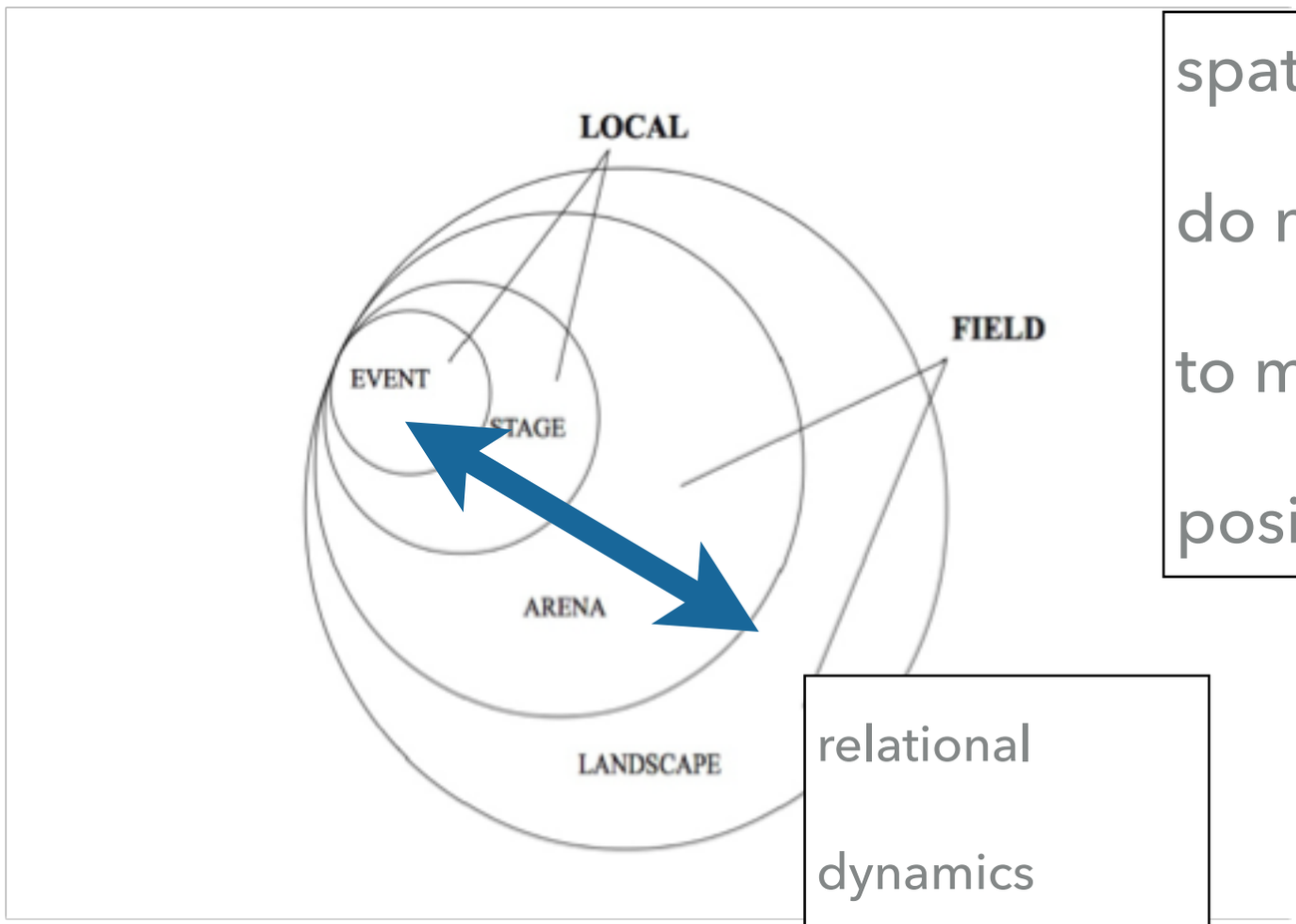


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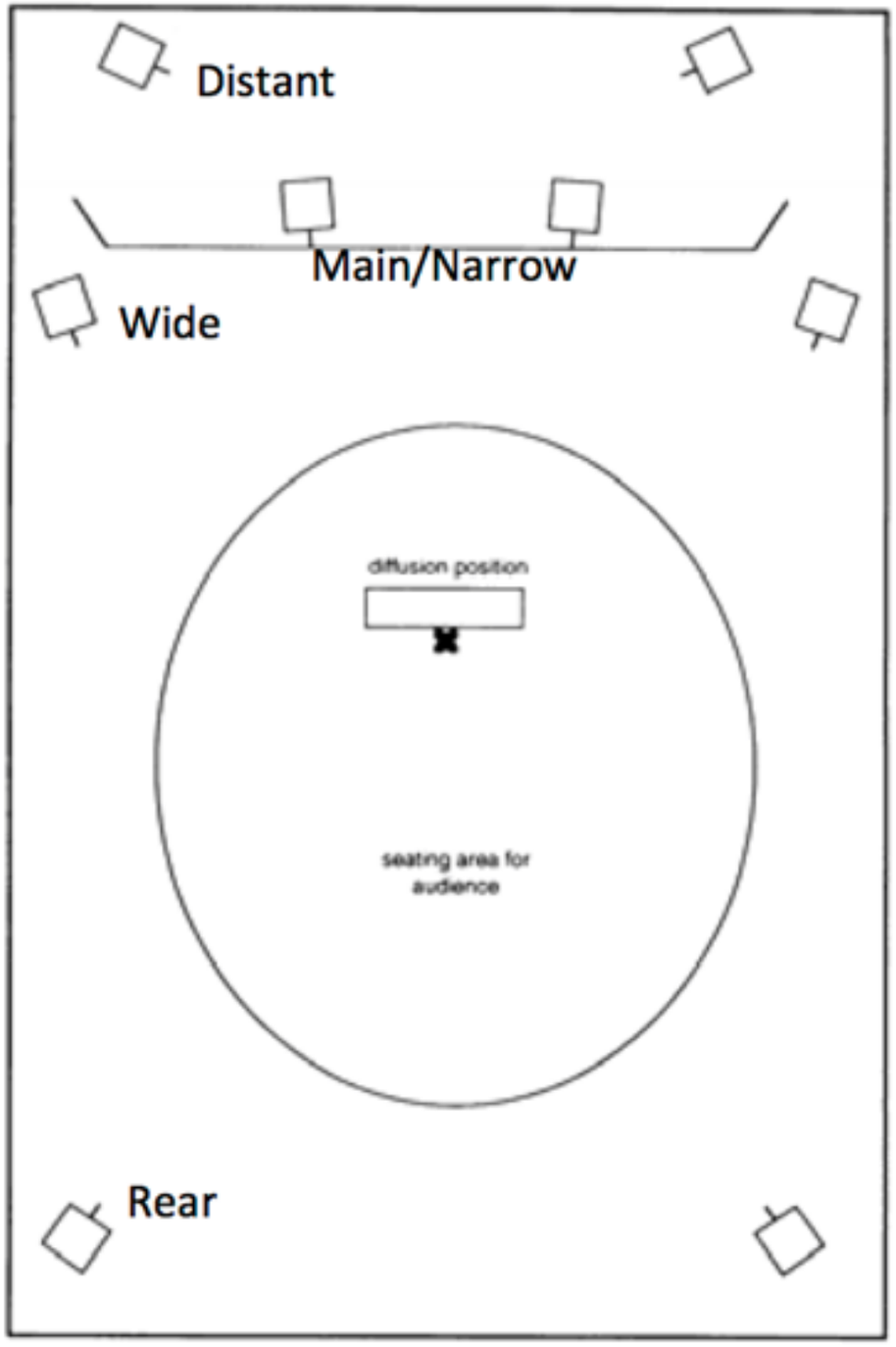
# SPATIAL AUDIO TECHNIQUES AND PHILOSOPHIES

- Two broad categories
- (a) Diffusion/'loudspeaker orchestra', focus on space-frame delineation and basic in/out, diffuse/point-source movements and dynamics (this approach is generally more ad-hoc, practice-led, based on experimentation)
- (b) Attempt to accurately recreate spatial audio cues and soundfield, generally via (relatively large number) of symetrically-placed speakers

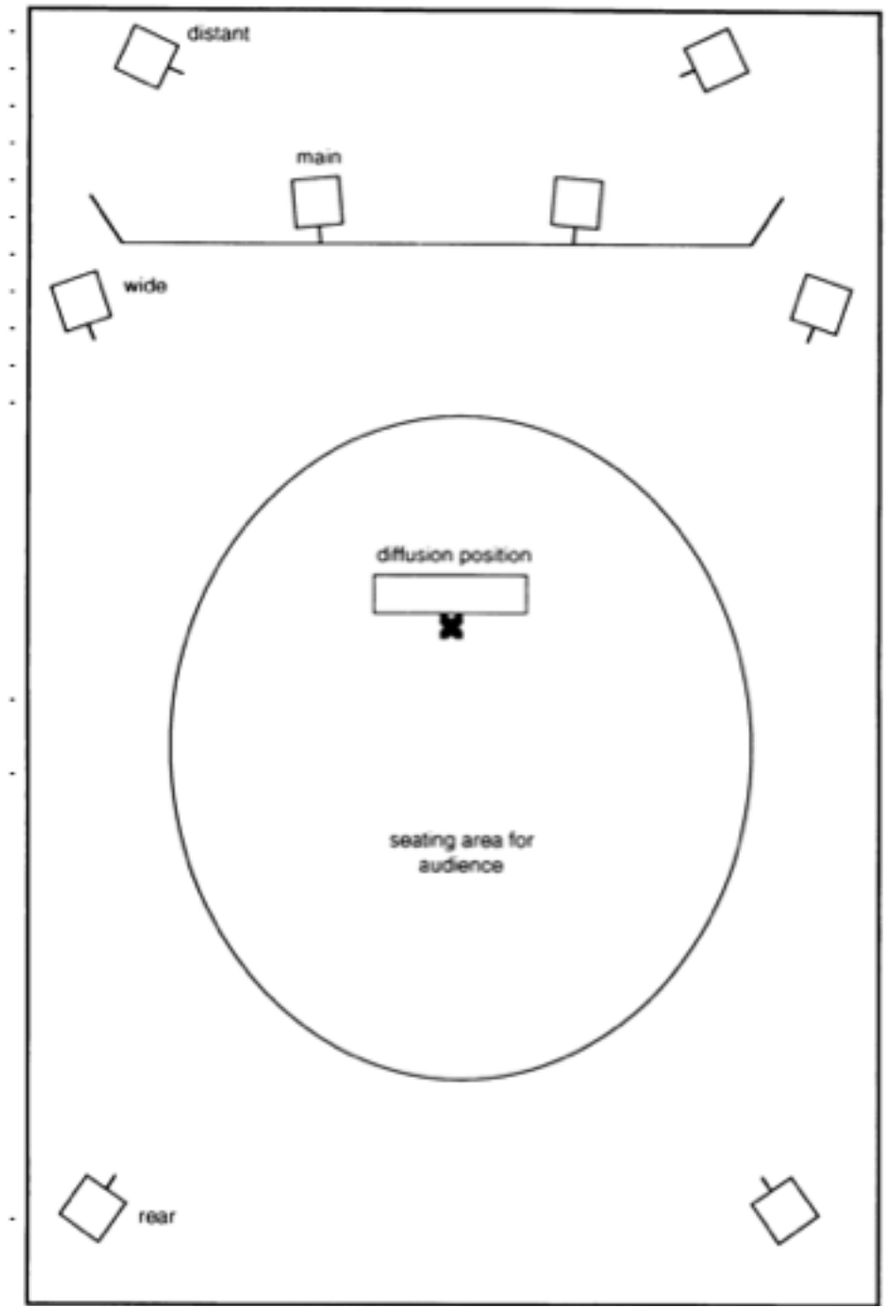
# (A) DIFFUSION/LOUDSPEAKER ORCHESTRA

- Diffusion setup (8-channel): the BEAST setup (after Birmingham Electro–Acoustic Sound Theatre); see Harrison (1998)
- Different stereo pairs serving different listener positions (and allowing for local/field, front/back or diffusion articulations, in addition to 'standard' stereo perspective)
- Often fed from stereo track to mixing console with 8 output busses (live performance!)
- Can create dynamic and performative impact
- Works well for material with significant transient detail (perhaps combined with more slowly-articulated envelopes)

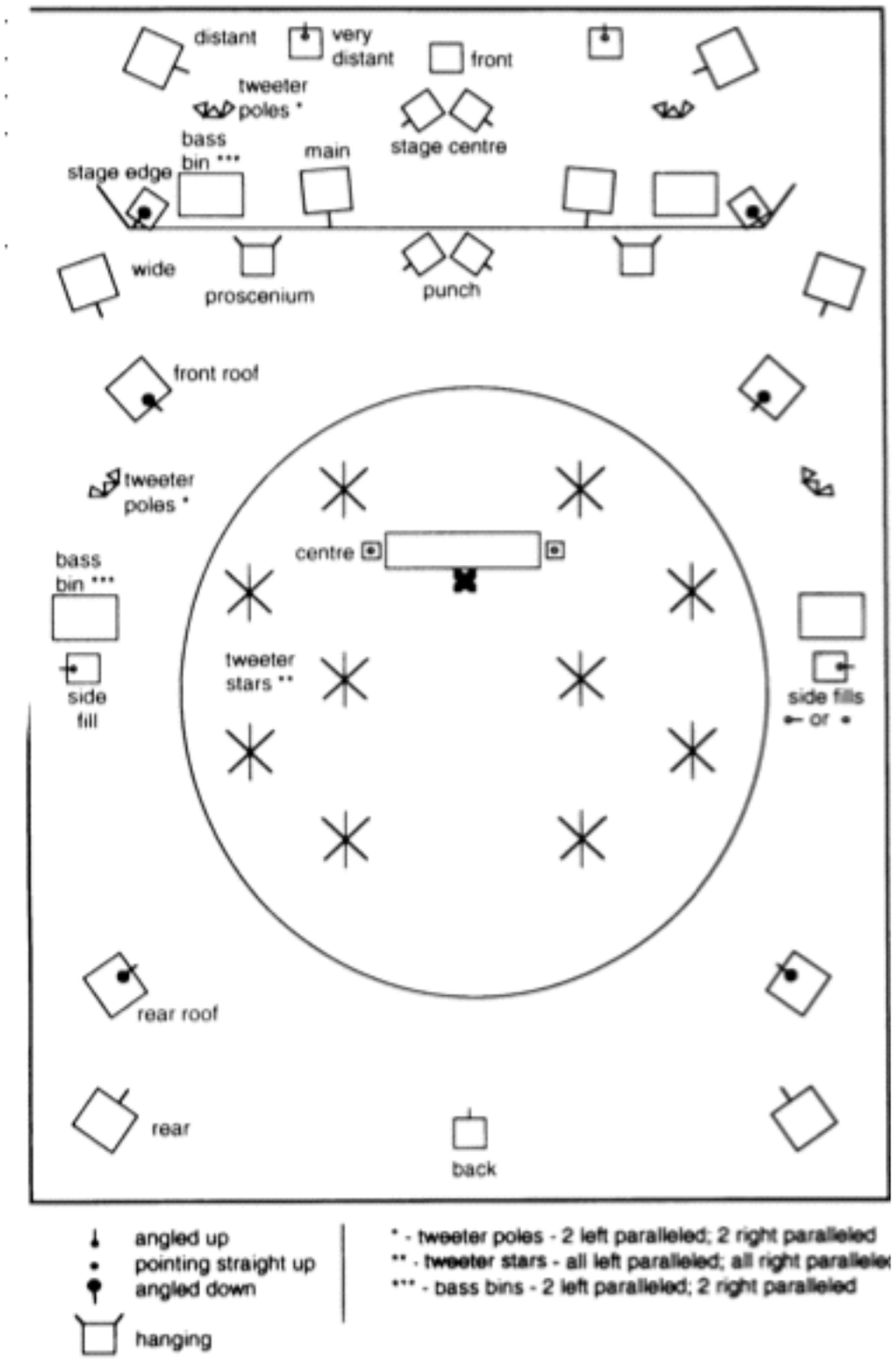


# HARRISON'S DIFFUSION AND THE BEAST

- Jonty Harrison is a composer who has worked extensively with diffusion
- Background: **limited 'sweet spot' for stereo** necessitates multiple speakers in concert hall to **fill in potential 'gaps' in stereo field at different locations** for a distributed audience
- Can feed different amounts to different speakers to increase dynamic range and draw attention to different parts of the performance/diffusion space
- Creates a performance out of a fixed media piece: Harrison (1998) 'the composer proceeds by drawing out implicit larger structures from the explicit morphologies of individual sound objects'
- Harrison/Birmingham initial BEAST setup: multiple stereo pairs; (1) standard, (2) wide, (3) distant, (4) rear)––latter apparently provides for 'anchoring' of stereo image



# EXTENDED BEAST




**Multiple diffusing speakers tailored to concert space**

**Open to criticism** - lots of potential for **out-of-phase sound** (same sound materials from multiple locations may create confused spatial imaging)

However, it does attempt to account for needs of distributed audience and tailoring to performance space (pragmatic approach) and is also quite dynamic/dramatic

# BEAST SETUP IN ACTION

https://www.youtube.com/watch?v=jM65sUdaS_4

# (B) RECREATING SPATIAL AUDIO CUES OR SOUND FIELDS VIA SYMMETRICAL SPEAKER ARRAYS

- We are familiar with one attempt to recreate spatial audio cues via the use of stereo panning based on equidistant stereo pairs using amplitude panning for simulating level difference cues

- A similar approach can be extended to spatial standards and approaches such as 5.1, 7.1, etc.

- 5.1 and 7.1 aren't symmetrical (and, as we've seen with 5.1, the rear speakers are badly placed in terms of providing clear left/right imaging and central image at the rear)

# (B) RECREATING SOUND FIELDS VIA SYMMETRICAL SPEAKER ARRAYS

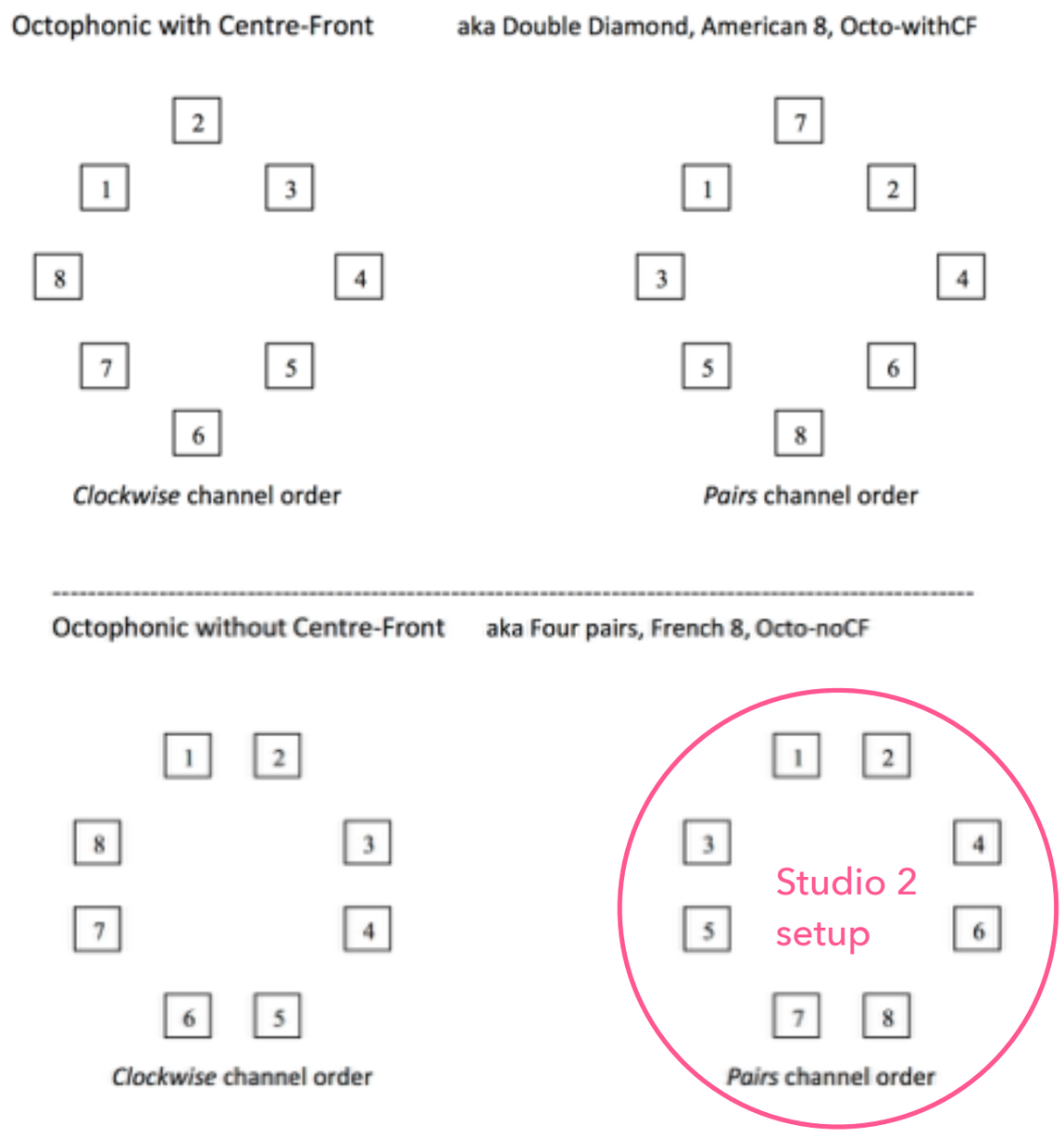
- We can try to use a fully symmetrical array (e.g. 8-channel/ octophonic ring setups); simple approaches would have you place an audio channel at each speaker or use basic panning to move sounds

- However, there is still the problem that simple amplitude panning (i.e. simple crossfading between speakers) doesn't properly recreate a more complex spatial soundfield

- A moving sound source will seem to 'jump' between different speaker positions rather than fading smoothly, and the image changes dramatically with different listener positions (nearest speaker heard affects apparent direction of sound)

- Solution: make a number of speakers contribute to the creation of the sonic image (more realistic recreation of soundfield)….find ways to 'pan' which involve a number of speakers, not just one or two

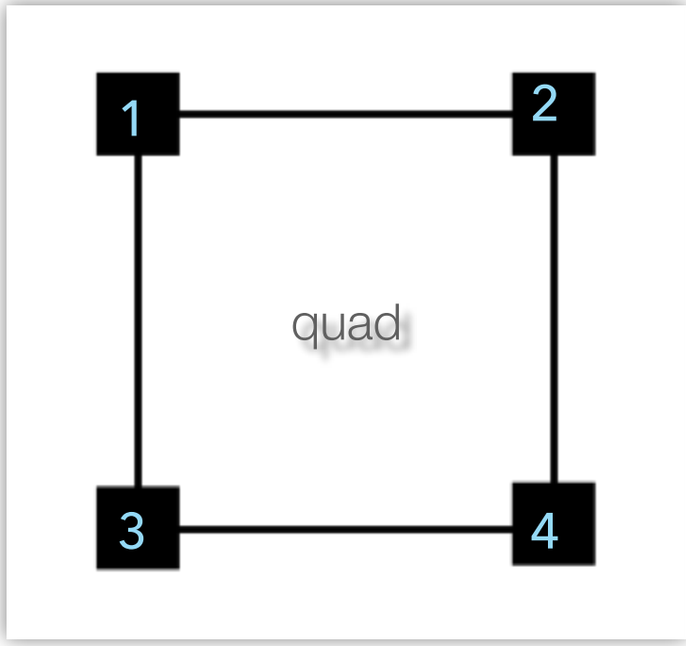
- We can event do this, to a certain extent, with simple 'channel placement' approaches to the sound (as we have seen)




8-channel variants; from Bates (n.d.)

# AMBISONICS: AWAY FROM DISCRETE-CHANNEL SPATIAL AUDIO

- So far, we have viewed spatial audio as being based on **discrete channels**: i.e. you assign a track to a particular speaker output, or you use a surround panner to crossfade a track between two different speakers...this is an intuitively clear approach, but it is **not necessarily the most efficient or accurate approach to multichannel audio**




- A particularly **problematic case for discrete channel approaches is that of the early quadraphonic standard (1970S)**: 4-channel audio with symmetrical speaker placement of 2 stereo pairs (front and rear)

- This produces a **90 degree separation between each speaker: this causes the virtual sound images found in stereo pairs of speakers to 'break down'** (60 degrees is considered to be the maximum advisable separation), resulting in the sound being heard 'at the speaker/ channel' as opposed to creating a spatial image with apparent realism between speaker positions

*In general, the **exclusive use of level-difference cues in discrete channel approaches is particularly prone to localisation errors**: moving closer to one speaker will significantly distort the spatial 'image'; c.f. Haas effect/law of first arriving wavefront*

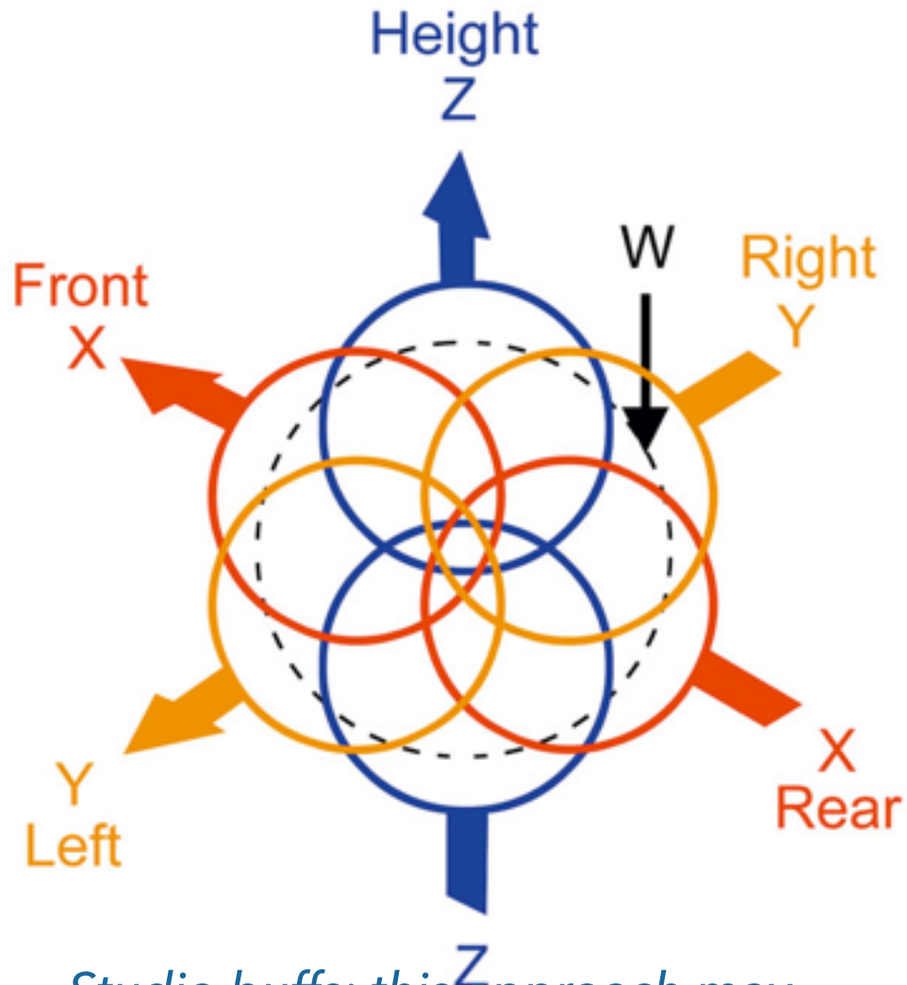
# AMBISONICS: AWAY FROM DISCRETE-CHANNEL SPATIAL AUDIO

- Therefore, for more accurate rendering/reconstruction of spatial sound, discrete channel approaches have significant limitations (particularly if a limited number of speakers are used)

- Michael Gerzon discovered an **alternative approach-- ambisonics-- based on trying to create a more accurate reconstruction/rendering of a spatial sound field** which is not subject to distortion based on speaker/listener position

- This approach is based on **using each speaker to contribute to the rendering of the sound field, rather than using a speaker only for a source at (or very near) its position**

- It does this by **splitting the sound into different components for overall level (marked W) and directional elements for horizontal and vertical directions (X, Y, Z)**. A given speaker will contribute a greater or lesser degree of the level info and directional components, depending on the location which is to be reproduced. [This 4-component signal is known as B-format.]



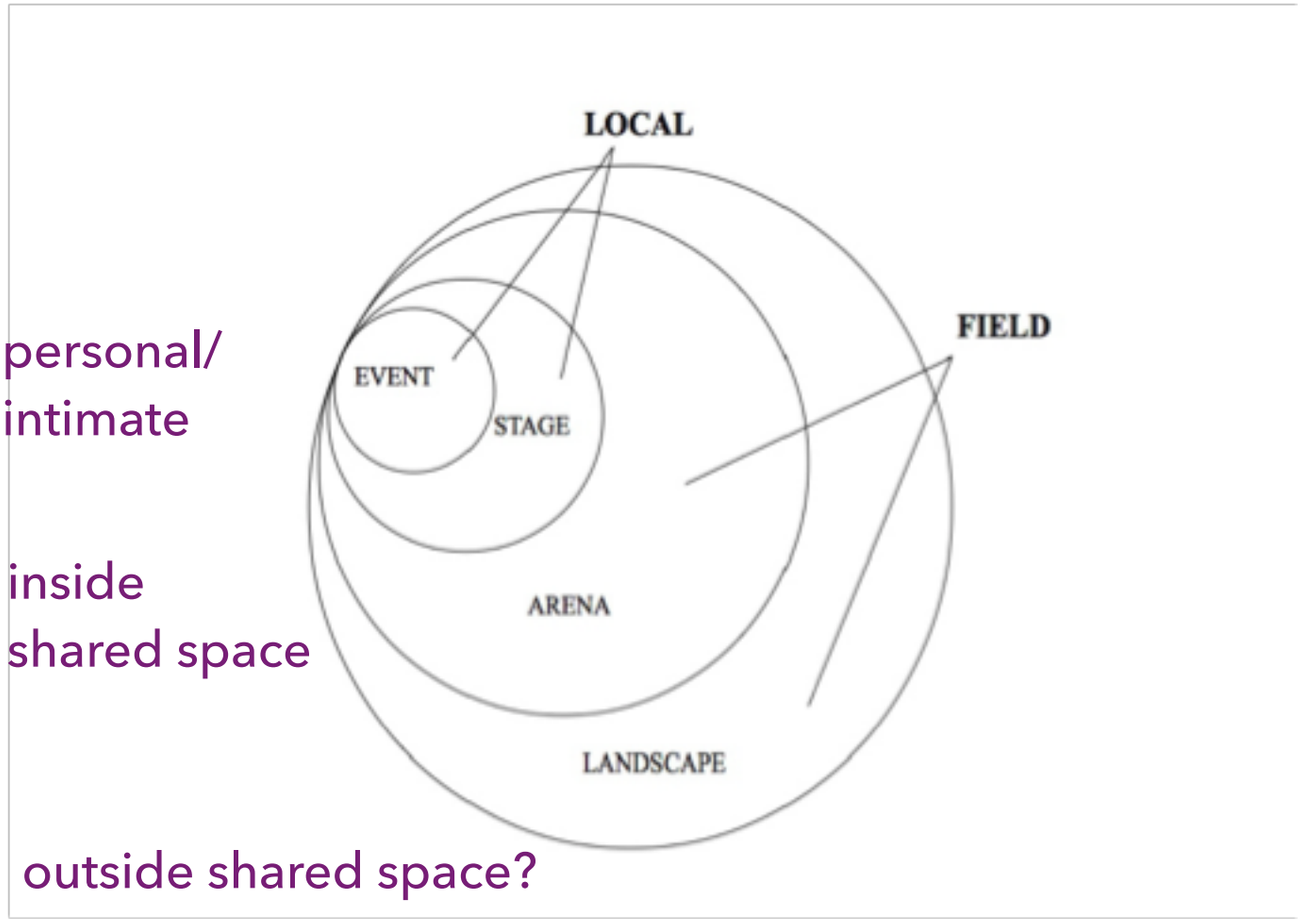

*Studio buffs: this approach may remind you of mid-side stereo recording: mid (omnidirectional mic) provides level, figure of 8 mic provides directional info)*

# AMBISONICS IN PRACTICE

- **In practice, ambisonics provides us with a means of encoding spatial information with a high degree of accuracy** (including vertical location, where applicable), which can then be decoded using a wide range of speaker setups
- **Mono signals/channels can be accurately and smoothly panned to a variety of apparently 'between-speaker' positions** by an application which calculates W, X, Y (and, if vertical aspect, Z) components for its intended location (and then decodes it to the speaker setup, with varying W, X,Y, Z components for each speaker)
- It is less susceptible to distortion of auditory perspective because a number of channels are contributing to the resulting sound, providing a more realistic approximation of an actual spatial soundfield
- **Very convincing spatial movements can be generated using this technique**: if you want a virtual source to smoothly circle around a listener's head, this is the approach for you
- **The good news:** an ambisonics application will do the encoding and decoding for you
- Studio demonstration (later): ICST ambisonics package within Max

# SPACES, FRAMES AND PRESENCE

## DIFFERENT SPHERES OF MUSICAL SPACE (AND SHARED/SOCIO–SONIC SPACES?)




Local/Field spatial model after
Emmerson (2007) *Living Electronic Music*

# MUSIC AND TRANSGRESSION (DISCUSSION)

- Which topics/musical acts are ‘fair game’? Are any topics ‘off limits’? are there any topics/ideas which music finds it hard to address?
- Permitted use of space vs transgressive use of space and territorialising sounded acts
- Use of found sounds vs plunderphonics and copyright infringement
- Repetition for aesthetic reasons vs repetition for dancing and other transgressive acts!
- ‘Valid’ representations of the human voice and emotions vs transgressive representation of human sexuality and other taboos

# EXPERIMENTAL/ELECTRONIC MUSIC AND POLITICAL OR OTHER TRANSGRESSIONS

- POLITICAL PROTEST: Salvatore Martirano - *L's GA* (for Gassed-Masked Politico,Helium Bomb,and Two Channel Tape) (https://www.youtube.com/watch?v=Q3B7alymQ6I)
- COPYRIGHT INFRINGEMENT or CONTROLLING AN ARTIST'S IMAGE? John Oswald, 'Dab' from *Plunderphonics* (Deleted CD release, 1996): https://www.youtube.com/watch?v=8xIWLG-F0Ag
- SEXUALITY: Charlotte Moorman and Nam June Paik: *TV Cello* and related works:

  https://youtu.be/-9lnbIGHzUM

  https://youtu.be/2aeH9FdtAqY

  https://youtu.be/3G3XomkkTPY

  https://youtu.be/B2xU4Arb8FI

*After three emancipations in the twentieth century music (serial, indeterminate, actional) I have found that there is still one more chain to lose. That is PRE-FREUDIAN HYPOCRISY. Why is sex a predominant theme in art and literature prohibited ONLY in music? How long can New Music afford to be sixty years behind the times and still claim to be a serious art? The purge of sex under the excuse of being 'serious' exactly undermines the so-called 'seriousness' of music as a classical art, ranking with literature and painting. Music history needs its D.H. Lawrence, its Sigmund Freud. (Nam June Paik, 1967, programme note for* Opera Sextronique*)*

*INDETERMINISM and VARIABILITY is the very UNDERDEVELOPED parameter in optical art, although this has been the central problem in music for the last 10 years, (just as parameter SEX is very underdeveloped in music, as opposed to literature and optical art.)" Nam June Paik, 1963, programme note for «Random Access Music: Exposition of Music – Electronic Television»*

# SELECT FURTHER READING: SPATIAL AUDIO, SPATIAL MUSIC


Bates, E. n.d. Octophonic Array Configurations. [online]. Available at: http://www.endabates.net/Octophonic.pdf [last accessed 3/2016]

Bates, E. 2010. *The Composition and Performance of Spatial Music*. (PhD dissertation, Trinity College Dublin). Available at: http://www.endabates.net

Bregman, A.S. 1993. Auditory Scene Analysis: Hearing in Complex Environments. In: McAdams, S. and Bigand, E. *Thinking in* Sound. Oxford: Oxford University Press, pp.10–36. Available at: http://webpages.mcgill.ca/staff/Group2/abregm1/web/pdf/1993_Bregman_Hearing-complex-environments.pdf [last accessed 4/2014]

Emmerson, S. 2007. *Living Electronic Music.* Aldershot: Ashgate.

Harrison, J. 1998. Sound, space, sculpture: some thoughts on the 'what', 'how' and 'why' of sound diffusion. *Organised Sound*, 3(2), pp 117-127. [online journal available through library]

Roads, C. 2015. Composing Electronic Music; a new aesthetic. Oxford.

Smalley, D. 2007. Space-form and the acousmatic image. *Organised Sound*, 12(1), pp 35-58. [online journal available through library]


Also: Divergence Press, issue 3 had a special issue on spatial music (edited by Prof. Eric Lyon from Virginia Tech): http://divergencepress.com/Journal/JournalIssue/tabid/85/articleType/CategoryView/categoryId/3/Issue-3-December-2014.aspx

Also: http://www.soundonsound.com/sos/jan01/articles/surround.htm

Also: http://film-mixing.com/2015/08/22/understanding-stereo-and-surround-pan-laws-in-pro-tools-and-dolby-atmos/