Towards 3-D Sound: Spatial Presence and the Space Vacuum

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An enduring auditory trope in science fiction cinema is the concept of 'silence' within a vacuum. Mechanical sound waves can travel only through matter. Since there is almost no matter in interstellar space, sound cannot travel through it. Yet, that reality presents particular challenges to filmmakers. It may be true that 'in space no-one can hear you scream', as the tagline to the film *Alien* (Ridley Scott, 1979) proudly declared, but literal representations of the silence of space rarely make for an engaging cinematic experience. Indeed, filmmakers have grappled with environmental verisimilitude in different ways, frequently ignoring physical laws or creating their own. This chapter considers some cinematic responses to the concept of the vacuum in space. I hope to advance the idea that the physical reality of the vacuum presents a particularly fascinating and challenging site for audience 'immersion'. Even though, to date, very few people have had any actual experience of space travel, filmmakers' desire to convince the audience that they are physically located within a mediated environment governs cinematic representations of outer space. The vacuum, therefore, presents a fruitful example of the conflict between scientific rationality and immersive impact, a scale that slides between knowing and feeling.

Immersion is a term that has gathered purchase in recent audiovisual scholarship, particularly in relation to videogames (Grimshaw 2007; Lipscomb 2004, McMahan 2003), yet it remains insufficiently explored and under-theorized. The more technically accurate psychological term is *presence*, the experiential counterpart of immersion. In this chapter I will adopt Wirth et al.'s (2007) theory of *spatial*

presence, which provides a framework for understanding how immersive media can inspire users to believe they are personally and physically present in the represented environment. This desire to 'be there' is clearly a central concern for many movies set in space. As Cara Deleon observes: 'The medium's goal is to create an environment in which the audience is fully immersed, no longer aware of the two-dimensionality on the screen' (2009, p. 10). By tracing some of the ways in which this two-dimensionality has been extended by sound-design and music, and their absence, it is possible to examine evolving strategies for spatial presence, which are married to shifts in technology and cinematic aesthetics.

We begin with Stanley Kubrick's *2001: A Space Odyssey* (1968), which established the idea that music can replace the vacuum of space. Growing from this fundamental concept we can trace an historical evolution in representations of outer space. Michel Chion's concept of the superfield described the sensation of complete space produced by multi-channel ambience outside of the visual frame. Mark Kerins' subsequent development and revision of this term for the digital age, the ultrafield, sought not to 'provide a *continuous* aural environment, but rather to *continuously* provide an *accurate* spatial environment where aural and visual space match.' The ultrafield is, therefore, explained as the 'three-dimensional sonic environment of the diegetic world, continuously re-oriented to match the camera's visual perspective' (2011, p. 92). I argue that we are moving beyond these conceptualizations from the superfield, via the ultrafield, to something that I will call *3-D sound*. This is an expansion and development of the characteristics of the ultrafield, partly afforded by the increased visual and spatial depth of 3-D cinema, requiring a more dynamic use of both music and sound. In particular, the emancipation of music from its traditionally fixed sound stage spatialization offers the most striking indication of an aesthetic and

technological turn. The result is that divisions between music and sound design collapse when the spatial domain is enacted as the dominant feature in the construction of a soundtrack. This is best illustrated by the film *Gravity* (Alfonso Cuarón, 2013), which redefined many of the unwritten rules of aural spatialization and motion. A film governed by the scientific principles of the vacuum offers an interesting glimpse into the future of the integrated soundtrack. This chapter examines the relationship between two types of spatial presence: the spatial presence that articulates the audience's suspension of disbelief and their subsequent location within a film's narrative world, and the spatial presence of sound and music within a multichannel cinema environment.

Spatial Presence

The term *immersion* has become a catch-all phrase to describe user experience, particularly in the humanities. Conversely, *presence* has been studied primarily by computer scientists and psychologists evaluating the effectiveness of virtual reality systems. Both terms have often been used somewhat interchangeably and it is worth clarifying an important difference and the implications of this for the study of the integrated multi-channel soundtrack.

Immersion is achieved by replacing as many real world sensations as possible with the sensations of a virtual environment. It is an objective description of what can be delivered by particular technologies (Slater and Wilbur, 1997). The aim of immersive technologies is to generate a sense that one has left the real world and is 'present' in the virtual environment. If immersion is the technologically-driven, objective aspect, presence is the perceptual outcome of that immersion. It is the psychological perception of 'being in' the virtual environment in which one is

immersed; the impression that a mediated experience is 'real'. As Lombard and Ditton explain in their frequently cited essay, presence is 'the artificial sense that a user has in a virtual environment that the environment is unmediated' (1997). [1]

The distinction is not just semantically expedient, because the perceptual/technological split reveals value judgements that frequently disconnect technical and aesthetic innovation, particularly in relation to movies. New film technologies have frequently been considered tawdry or gimmicky, restricting rather than enlivening, and somehow damaging to the purity of the cinema. Tim Recuber, for example, identifies a range of high-fidelity audiovisual technologies designed to enhance the kinaesthetic experience of the audio-viewer, which he calls 'immersion cinema'. He argues that these emphasize 'technical achievement to the detriment of social or artistic relevance' while simultaneously embedding a 'passive, consumerist ideology within the spaces of contemporary moviegoing' (2007, p. 316). Critical responses consistently state that artistic integrity is drowned by the immersive technologies of spectacle. The recurrent historic discussions around stereoscopic cinema are a case in point (Holmberg, 2003; Kermode, 2009).

It is telling that Neuendorf and Lieberman, on the other hand, seek to identify and celebrate the correspondences between technology and aesthetics in their adoption of the term presence. They suggest that cinema was 'the original medium of presence' and that the history of film is one of 'striving for an ever-greater level of presence through technological innovation, changes in aesthetic form, and developments in narrative structures and performance styles' (2010, p. 9). The significant difference in their stance is that presence is understood as a cognitive process, it is the result of perception rather than just a series of physical sensations, and it is recognized as multimodal and experiential. Presence can happen in different

kinds of films, not just those that avail themselves of the most advanced immersive technologies, because mental constructions are more important than the mechanics of the stimuli.

By aligning ourselves with this position we are able to identify and dismantle some common fallacies. The first is that the more pervasive the technology—further surround sound channels, a larger screen—the more complete the mediated world will seem and the more immersive the experience will be. I am sure that I am not alone in experiencing deep engagement and effective suspension of disbelief while watching small screens and listening to a limited stereo field. In line with Bracken and Skalski (2010), therefore, I am inclined to identify presence in a range of conventional and everyday media. This will be significant when it comes to our discussion of *Gravity* (2013), because it is not automatically the technical innovation of Dolby Atmos[2] or the increased number of surround sound channels that make spatial presence more probable, but rather the bold aesthetic decisions that derive from the way that this technology has been applied.

Furthermore, because the mediated environment is a precondition for presence, we can identify ways in which the experience is different from the real world. Some scholarly definitions of immersive experiences are close, if not identical, to descriptions of nonmediated reality (Mantovani and Riva, 1999). But *spatial presence*, as defined by Wirth et al., requires an appreciation and acceptance of the 'rules' of a media environment, a process of self-orientation in relation to it, and entry to and exit from the mediated world. It is an experience that can be enriched but does not entirely depend on external mediatized information. It is the term *spatial presence*, then, that comes closest to what I suspect film audiences think of as immersion. For spatial presence to occur, the technology disappears, at least to some degree. Consequently,

spatial presence must be understood as a cognitive and experiential process, rather than defining the technologies of immersion as automatically engrossing or engaging. There is, indeed, sophisticated interplay between the mental and the experiential where technology and aesthetics are unified.

Wirth et al.'s 'Process Model of the Formation of Spatial Experiences' (2007) is useful, therefore, because it integrates a range of existing theories from psychology, communication, and virtual reality into a clear and unified procedural structure. It identifies how audio-viewers can be made to feel like they are leaving the real world behind. Importantly, the authors argue that 'spatial presence is not bound to virtual reality, but can also occur in users of conventional media, such as books or television' (2007, p. 495). Wirth et al. argue that spatial presence requires a journey across two levels. At the first level a spatial situation model (SSM) is created. High levels of involvement and suspension of disbelief result in spatial presence at the second level. At the risk of over-simplification, the two stages of the model could be summarised as follows:

1) Audio-viewers develop a *mental representation* of the space or world that the media presents to them and form a spatial situation model (SSM).
2) Audio-viewers begin to *favour* the media-based space as the point of reference for where they are 'located'. The mediated space then becomes the Primary Egocentric Reference Frame (PERF).

These stages can be explored in a little more detail. Interrelated audiovisual objects and assumptions about the represented world based on real or mediated 'personal spatial memories' (2007, p. 501) help audio viewers form a mental model of the film's mediated space. There is a continual process of interpretation and mental construction that evaluates the congruence of the perceived spatial environment with

the spatial situation model. This process, therefore, highlights 'how many aspects/details are salient that fill the imagination as well as how plausible and coherent the imagined space is' (2007, p. 502). The various spatial and sensory elements must be appropriately rich and, since film is multimodal, the 'information provided must be consonant across the modalities in order to increase consistency' (2007, p. 502). Richness in this context means rich *enough*, but not necessarily a direct replication of actual reality. Richness could be achieved, for example, by strong narrative structure as much as by the completeness of sensory information. Wirth et al. sum this up as follows: 'A variety of concise spatial cues (preferably within different perceptual channels), which are linked in a consistent and plausible manner, should evoke both richer and more internal consistent SSM's than those presenting only a few, diffuse or inconsistent cues' (2007, p. 504).

Once the mental model has been created, the audio-viewer must subconsciously decide whether they feel like they are in the imagined world or in the real one. This is conceptually different from stage one because spatial situation models are 'mental representations, whereas Spatial Presence is regarded as an experiential state' (2007, p. 504). Wirth et al. consider the state of spatial presence as binary (on/off) and, at its emergence, the audio-viewer aligns their spatial perceptions within the mediated environment rather than any other possible frame. This is what has been labelled the Primary Egocentric Reference Frame. An audio-viewer accepts the mediated environment as the PERF, because 'perceived self-location, perceived possible actions and mental capacities are all bound to the mediated space' (2007, p. 506). Various media factors and user characteristics can enhance or hinder both stages of the processes that lead towards the state of spatial presence, but it is important to note that this is a fluid state that can be entered and exited repeatedly.

This process model presents one way to understand what is necessary for spatial presence to take place, but it also presents a particular challenge when we consider the filmic representation of interstellar space, especially in relation to the concept of the vacuum. In cinematic representations of, for example, spaceships travelling through space, knowledge of reality suggests that these shots should be presented in silence, but this is rarely the case. The lack would immediately pull the audio-viewer out of any mediated spatial presence, or in Wirth et al.'s formulation, the audio-viewer's Primary Egocentric Reference Frame would return to the auditorium or other environmental frame. The lack of sensory completeness, the loss of an important channel of information, the inconsistent behaviour from the represented world (unless the film is completely silent throughout), and the creation of a cognitively less demanding environment would point towards incompleteness, a loss of richness, and a break in the illusion of the mediated reality. The cinematic space vacuum frequently presents a clash between what audiences know *about* reality and what they must feel in order to believe the representation *as* reality. Mediated sensory completeness is in direct conflict with nonmediated reality, plausibility is in conflict with imagination, and credibility of one kind is challenged by credibility of another. Wirth et al. hint at this when they suggest that 'spatial knowledge and spatial imagination become more relevant if the mediated representation of the space is less intuitive and more fragmented' (2007, p. 502). It is unsurprising, therefore, that filmmakers have consistently found interesting ways to fill the gap.

Ye cannae change the laws of physics[3]

In a striking scene in *2001: A Space Odyssey* (1968) 'suspicious' supercomputer HAL cuts Dr Frank Poole's (Gary Lockwood) oxygen hose while the astronaut attempts to

reinstall a component of a faulty antenna and he is sent spinning into the void to his death. We see the tiny figure of the rotating astronaut, but we hear nothing. For a very brief moment the soundtrack is completely and eerily silent. Stanley Kubrick's determination to ensure that the film was scientifically accurate is well documented (Kolker, 2006; Kirby, 2013). Several technical advisors were hired, including experts in aerospace engineering and artificial intelligence. This realistic depiction of outer space resulted in the very carefully controlled representation of the propagation of sound. Chion describes the strategy as follows:

> For the sequences of space travel, when the camera is filming from without like an eye floating in the void, Kubrick appears to apply a simple principle faithful to physical reality: since there is no sound in a vacuum, there will not be the slightest sound linked to operations or movements of machines. (Chion, 2001, p. 98)

Despite this governing principle, the use of absolute silence is confined to Frank Poole's death scene. Elsewhere the film employs music to replace the silence of the vacuum or, alternatively, as the Jupiter Mission progresses, there is an increasing use of 'objective-internal sound', which Chion describes, in this context, as the sound of breathing inside an astronaut's helmet (2001, p. 99), but this term could also be applied to heartbeats or other sounds that correspond to the physical and mental interior of a character. It seems to me unlikely that the audience would experience spatial presence for much of this film, because Kubrick constantly places the audio-viewer 'outside' the action, and the film requires continuous contemplation and questioning. But we do move further towards spatial presence, I suggest, in the stargate sequence where Dave Bowman's (Keir Dullea) psychedelic sound and light journey allows him to travel to another dimension. The rather literal representation of

the silence of the vacuum at Frank Poole's death, therefore, marks the point at which the film shifts from the realistic to the experiential, where the limits of our knowledge of space travel define the perceptual framework.

Let us explore that trajectory. Roger Ebert argues that in the famous 'Blue Danube' docking sequence 'even the restless in the audience are silenced, I imagine, by the sheer wonder of the visuals' (1997). Silenced perhaps, but not spatially present. Even though the Strauss waltz replaces the sound of the vacuum and, therefore, partially supports the sensory completeness that Wirth et al. argue is required for spatial presence to take place, the music and image are not consonant. Royal S. Brown has described the music in *2001* as a 'parallel emotional/aesthetic universe' (1994, p. 239) and other writers have also noted the deliberate sense of dislocation between music and visuals (Gorbman, 2006, pp. 4–5). For Chion, despite the breathtaking brilliance of the sequence, 'something is missing in all this dancing plenitude' (2001, p. 94). It is music that creates an expressive contrast by its very indifference to the situation on the screen, it is *anempathetic* (Chion, 2001, p. 94). The combination of music and image, then, in this and other scenes in *2001*, demands a cognitive process that distances the audio-viewer from the representation of mediated reality. In terms of the spatial situational model, the audio-viewer cannot progress to stage two because even though a mental representation of the presented world is encouraged, it cannot become the point of reference while the Primary Egocentric Reference Frame is held in suspended animation by the discordant audiovisual choreography.

The sequences of Frank Poole's space walk and manouvering using the Extra Vehicular Activity (EVA) pod move somewhat closer towards spatial presence, it seems to me, because of a closer internal association with the character. It is aural

design that might imply greater subjectivity, but Chion is right to call this 'objective-internal sound', because even though we hear Poole's breath—accompanied by the continuous hiss from the air supply—it is always presented from the same aural perspective. The visual construction of shots, on the other hand, radically alters the spatial perspective. The sound remains fixed regardless of whether we are inside or outside of Poole's spacesuit, inside or outside of the EVA Pod, or whether we see wide shots of spacecraft or close-ups. Therefore, breath sounds function like ambiance, generating an objective rather than subjective aural perspective.

When Bowman attempts to rescue his colleague we see external shots of the EVA pod and Poole's body floating in complete silence. These are some of the most ghostly scenes in all cinema. There is an accurate representation of movement through the silence in the vacuum, but this does not encourage spatial presence. The lack of sound, though scientifically accurate, stands in opposition both to the multimodal nature of human existence and the multimodal nature of the cinema as we know them. The presentation of isolated moments of emptiness are stark in contrast to the 'complete' spatial environments elsewhere in the film. We are so attuned to the synchrony of sound and image in our world that in this filmic context a lack can only be read as a lack.

The contrast between this painful, beautiful and eerie silence and the plenitude of the stargate sequence is marked. When Bowman enters the stargate, a psychedelic audiovisual journey begins. The visceral and sensory experience encourages spatial presence. The audio-viewer is persuaded to enter the infinite corridor of light and sound rather than to act as objective observer of that space. Chion suggests that at this point in the film 'all notions of realism or unrealism become irrelevant' (2001, p. 100). He is right, up to a point, but realism in this context relates to what the audience is

prepared to accept. It is a credible representation of a fantastical environment, allowing a mental representation to be formed. It could be argued that the use of manipulated versions of Ligeti's *Atmospheres* and *Adventures* in this sequence act as the 'voice' of the monolith. Yet, Ligeti's music functions in a different way in the stargate sequence. In two previous mysterious presentations, the monolith is enacted by the music, which gives it weight, depth and scale, but in the stargate sequence the music and image are enacted by their interaction with each other. The music is given greater energy by the light fields rushing towards the audience and the corridor of light is given depth and perspective by the music. It is a rich, multimodal spectacle that places the audio-viewer directly at the centre of the experience and aligns spatial perceptions within the mediated environment.

To be sure, Kubrick did not seek to create a film that encouraged spatial presence throughout, although it certainly aimed for the spectacular. *2001: A Space Odyssey* preserved and prioritized environmental verisimilitude while also moving towards spatial presence, yet for much of the film's duration the audience is kept at a deliberate intellectual distance.

It is very rarely noted that *2001's* première and Roadshow Theatrical Release featured a six-track stereo magnetic soundtrack.[4] HAL's voice issued from the surrounds and generated an effective acousmêtric all-seeing and all-knowing authority.[5] In its thirty-five-millimetre anamorphic general release format, however, the film included either a four-track magnetic stereo soundtrack or an optical monaural soundtrack.[6] Audiences in the late 1960s, therefore, experienced very different spatial manifestations of the sound of the film, defined by both the nascent technology and exhibition limitations of the time.

Only a few years later, the refined surround capabilities offered by the Dolby Stereo format presented a new challenge to director George Lucas and the sound team for *Star Wars* (1977).[7] How could immersive surround technologies be effectively deployed if sound could not travel in space? Thus, fidelity to the laws of physics was abandoned, the vacuum was filled with air and sound could once again propagate. This 're-inflation' partly reflects the hybrid science-fiction/fantasy genre of the film, but I also suggest that the abandonment of scientific rationality was primarily at the service of spatial presence. In the first few minutes of the film, following the opening titles, the concept of the silent vacuum is, quite literally, blown apart by a series of explosions as a rebel ship flees from an Imperial Star Destroyer. Travelling overhead we hear the mechanical whirr of the rebel ship and a series of directional laser bolts. These sounds are engulfed by the low rumble and roar of the Star Destroyer, which travels from the back to the front of the auditorium. The audio-viewer is encouraged to feel the spatial location, size, scale and weight of these vessels. There is an immediate sense of being at the heart of the skirmish.

Later, in the battle that eventually destroys the Death Star, ships zip from left to right, a torrent of lasers and blasts are heard around the auditorium. Enemy craft chase Luke Skywalker's (Mark Hamill) X-wing starfighter through a narrow trench. He must fire proton torpedoes into a thermal exhaust port at exactly the right moment in order to destroy the Death Star. The design of this sequence seems to be a precursor of the racing videogames that would become prevalent in the 1980s. William Whittington acknowledges this perspectival approach suggesting that 'sound design allows the filmgoer to ride the film rather than simply view it' (2007, p. 108). The audio-viewer frequently experiences a first-person perspective with the gaze drawn towards the centre-back of the screen, while credible environmental directionality is

provided by the sound. At key moments in this film where, rationally speaking, silence in the space vacuum should prevail, we find the exact opposite. In terms of the potential for spatial presence, the construction of the spatial situation model (SSM) is carefully controlled to direct the audio-viewer's attention. But it is not simply the plenitude of the local multimodal experience that encourages this. At this point in the film the audio-viewer is narratively empathetic, having followed Luke's development from cocky teenager to rebel hero. Obi-Wan's (Alec Guinness) sacrifice has set Luke free to understand how to use the 'Force'. Therefore, the climax of the film, the peg on which the narrative resolution hangs, is also the point of greatest potential spatial presence. We might also observe, retrospectively, that a similar narrative principle is in action in the stargate sequence in *2001*.

Gianluca Sergi notes that the key innovation of *Star Wars* was the conviction that it provided a 'unique opportunity to change radically sound exhibition' (2010, p. 15). It was released in the Dolby Stereo format in over fifty percent of its first release theatres and it had a profound impact on both aesthetic practices and exhibition technologies in the years immediately following (Kerins, 2011, p. 32). Sergi also notes that in *Star Wars* the surround channel was 'less a means to provide music and some rare ambiance effects, than a source of primary sound information' (2010, p. 17). This description seems to straddle and problematize the borderline between Chion's notion of the superfield and Kerins' concept of the ultrafield.

Pseudo-silence: Houston we have a problem

Chion describes the superfield as the 'space created, in multitrack films, by ambient sounds, city noises, music, and all sorts of rustlings that surround the visual space and that can issue from loudspeakers outside the physical boundaries of the screen'. He

argues that the ensemble of sounds have a 'quasi autonomous existence with relation to the visual field' (1994, p. 150) because it does not depend moment by moment on what we see onscreen. If Chion's concept can be applied to the use of analogue surround technologies and the aesthetic approaches that relate to them, Kerins extends this concept in light of developments in Digital Surround Sound. It does not render the superfield extinct, rather it is an evolution beyond the limits of Dolby Stereo. Sound now leaps even further off the screen and extends to the whole of the cinema auditorium.

> I dub this updated superfield the *ultrafield*. It differs from the Dolby Stereo-based superfield in two key conceptual ways. First it sacrifices the 'invisibility' of sound editing and mixing to embrace digital surround's aforementioned capabilities to exploit active and changing sounds. Where the superfield maintains a sonic continuity, the ultrafield constantly shifts sounds around the multi-channel environment. Second it encompasses a much broader array of sonic elements than its predecessor. Where Chion limited the superfield to ambient sounds and noises, the ultrafield encompasses not just these background sounds but the entire aural world of the film including sound effects, dialogue and diegetic music. (2011, p. 92)

Why only diegetic music? In Kerins' definition sound moves but non-diegetic music does not. The ultrafield, then, defines its boundaries in the three-dimensional sonic environment of the diegetic world, but does not resolve the use of non-diegetic music in spatial terms. For this innovation we must wait until the aesthetic and technical developments of 3-D sound. What we have witnessed thus far in the challenge of depicting the space vacuum is an historical trajectory where pure objective internal sound or music replaces the void of space, next the principles of the vacuum are simply ignored and sound-design rejects environmental accuracy in the service of spatial presence. As we shift from the superfield to the ultrafield era, we find increased efforts to reconcile scientific fact with dramatic fantasy. I call this

hybrid attempt to find a representational middleground *pseudo-silence* (which could also be understood as pseudo-science). It is, of course, always designed to enhance spatial presence.

A film such as *Apollo 13* (Ron Howard, 1995), which won an Academy Award for sound, makes effective use of exhibition technologies and flexible digital tools for sound manipulation early in the ultrafield era. Sound and music primarily remain spatially fixed and maintain sonic continuity. Yet, there is also some exploitation of active and changing sounds within digital surround systems. This partly reflects the fact that *Apollo 13* is a docudrama, which implies a greater emphasis on realism. In comparison to *Armageddon* (Michael Bay, 1998) David Sonnenschein argues that '*Apollo 13* is more reality-based and takes this interpretation of space literally by having the ship move silently' (Sonnenschein, 2001, p. 127). The Apollo 13 is certainly quieter than spacecraft in *Armageddon*, yet it is not accurate to state that the ship moves silently. External shots of the spaceship are, in fact, always accompanied by 'whooshes' from gas thrusters, or other rumbles. Any static external shots of space are always filled with front-focused quiet music and/or radio chatter. Flying debris is always accompanied by sound. Even a shot showing an overboard dump is accompanied by its own 'spray' sound effect, which astronaut Fred Haise (Bill Paxton) calls 'constellation urine'. It is interesting to note, therefore, that Sonnenschein perceives silence in this film's representations of outer space. I suggest that this is, in fact, carefully crafted *pseudo-silence*. It is an attempt to imply absence through a marked reduction in ambient sonic material but not through its entire omission. Furthermore, individual spot sound effects remain, but these are not particularly dynamic in terms of their movement in the surrounds. Conversely, on Earth we find a greater use of the surrounds and considerable digital manipulation of

'sound materials' that is typical of the ultrafield era. For example, after Jim Lovell (Tom Hanks) reveals that the Apollo 13 is venting oxygen into space, we witness mission control's shocked reaction followed by a flurry of nervous activity. There is an eruption of sound that envelops the audience: radio chatter, panicky conversations, a polyphonic mass of dialogue in all auditorium speakers that reflects the chaos of the situation. The earthbound directional use of sound is, therefore, often more adventurous than the sound in space because of the challenge of representation in the space vacuum.

One scene in *Apollo 13*, however, radically challenges the notion of pseudo-silence in the space vacuum and points some of the way towards 3-D sound. This is a nightmare sequence representing Marilyn Lovell's (Kathleen Quinlan) fears for her husband's safety. Following an unspecified problem aboard the ship, numerous alarms are heard (in the full spatial speaker array), glass smashes, a pod bay door is sucked out into the void and the cabin is depressured. Jim Lovell is dragged out of the spaceship. The amplitude and complexity of the soundscape increases and there is a powerful spectral fusion of sound-design and music. The increased use of the surround speakers and, especially, increased use of sound in the Low Frequency Effects (LFE) channel (sometimes also called the subwoofer) helps generate a kind of distorted wind effect. There is extensive use of reverb in all channels, a rhetorical device that signals that the scene does not represent 'reality'. This bold aural representation suggests the potential for integration of music and sound in cinematic representations of the space vacuum.

Moving ahead some fifteen years, towards what I suggest is the beginning of the end of the ultrafield era, we see the continuation and development of the principle of pseudo-silence in J.J. Abrams' reinvention of *Star Trek* (2009). Early in the film a

Klingon vessel blows a hole in the hull of the U.S.S. Kelvin and a woman is sucked out into space. When the unnamed crewmember is outside of the ship, a state of pseudo-silence is heard. Furthermore, the sound and music are directionally sucked out with her as an aural representation of the vacuum. Whistling wind is heard, yet the screams of the doomed crewmember stop. The full visual perspective of the battle is displayed, yet explosions and phaser fire are absent. Later and throughout the film, however, the audience does hear explosions, weapons fire, crashes, and engine rumbles in outer space. These sounds are directional and take full advantage of the surround speakers.

A further hybrid approach to pseudo-silence is heard when Kirk (Chris Pine) and two other crewmembers 'space jump' from a shuttle in outer space into the Romulan atmosphere, falling at considerable speed towards the alien planet. The sequence begins in pseudo-silence featuring quiet 'wispy', 'wailing' sounds that develop inharmonic ambiguity with shifts between intervallic pitch and noise. Then breath is introduced to the sound mix, finally wind, gestures of bodily movement and vocalizations are included. The sound design becomes fuller as the characters fall further into the atmosphere and more air is available to conduct the sound. Nowhere in the sequence is there absolute silence.

Attempts to encourage spatial presence in the ultrafield era frequently employ an aural middleground that carefully manages the amount, frequency and spatialization of audio material. Whittington suggests that every film since *Star Wars* has ignored the vacuum. The decision to render space with sound has coloured 'the sound tracks of every subsequent science fiction film' (2007, p. 108). In fact, illusions of both silence and of the physical reality of the vacuum are created, but audio material is never reduced to the extent that spatial presence may be compromised. I

argue that this represents an aesthetic desire and drift towards 3-D sound, which is finally afforded by developments in digital sound and visual technologies in the late 2000s. Neuendorf and Liebermann suggest that creating a convincing three-dimensional soundscape is one of the most valuable aspects of the role of sound-design in the creation of spatial presence, but if the soundscape does not match the two-dimensional image it might 'be a deterrent to a sensation of full immersion' (2010, p. 23). This is, indeed, the defining boundary characteristic of Kerins' notion of the ultrafield where the three-dimensional sonic environment of the diegetic world is 're-oriented to match the camera's visual perspective' (2011, p. 92). Yet, in 3-D Sound, just as the visual perspective is dimensionally extended, so is the soundscape.

3-D Sound or the Gravitational Pull of *Gravity*

Gravity is a film governed by the space vacuum. It is also deeply concerned with the spatial organization of its audiovisual materials. Director Alfonso Cuarón's solution to the challenge of presenting a narrative within the vacuum was to acknowledge the fact that sound cannot travel through the atmosphere but can be transmitted through the 'interaction of elements, meaning that if our characters grab, or touch stuff, the vibration of that will travel into their ear, and so they will get a muffled representation of that sound' (Coleman, 2013). The sound-design team recorded many of the sounds using contact (transducer) microphones, which are attached to the surface of objects and record their vibrations rather than the vibration of air. Stuart Bender describes the impact of this approach in terms of its defamiliarization (2014). Furthermore, Cuarón explains that, '*Gravity* is a film that has designed itself for a surround system. The sound is constantly traveling, it is very dynamic' (Coleman, 2013). The film was released in the majority of cinemas in 7.1 surround (7.1 splits the existing Left

Surround and Right Surround channels of 5.1 into four 'zones'), but also in Dolby Atmos in theatres that were equipped with the new technology.[8] Atmos is the first commercial audio format based on audio objects rather than channels. This means that any sound can exist as a discrete audio object, free of channel restrictions, and can be precisely spatially located anywhere in the auditorium, including overhead, and can be fluidly and seamlessly moved through space (Dolby 2014).

This technical development runs parallel to the mainstream resurgence of stereoscopic 3-D visuals from 2009 onwards. However, it is not the innovation in audiovisual technology, on its own, that encourages spatial presence in *Gravity*, but rather the connection between technical advance and aesthetic lucidity deriving from the way that technology has been deployed. Sound design's place in the aural environment of the movie is justified through haptic perception; in order to be heard sound must be quite literally touched. This immediately ties the sound-design to the embodied experience of the characters. In the physical and conceptual gap vacated by this approach, music is suddenly free to move spatially in a way never before achieved in commercial cinema. Furthermore, the clear criteria given to sound design and music result in their detailed integration within a symbiotic soundscape. Metaphorically, we could refer to the 'gravitational pull' of the film, which attracts physical bodies of sound and music to each other with the result that they are able to interact in radically new ways. The movie's composer, Steven Price, identifies how this hybrid conception affected his scoring parameters: 'Alfonso wanted me to try to express things that ordinarily would be sound in a musical way. So the composition serves a dual purpose' (Schweiger, 2013). *Gravity*'s soundtrack generates exceptional integration between sound-design and music precisely because the aesthetics of spatialization have been foregrounded in the space vacuum.

One of the defining characteristics of what I call 3-D sound, then, is that music is emancipated from a fixed sound-stage representation. Indeed, music begins to function with a similar kind of directional freedom that has been typical of sound-design in the ultrafield era. At the same time, music is not tied to environmental 'reality' in quite the same way as sound-design, so music is, in some ways, able to move *more* freely. All in all, this means that the borders between what have traditionally been considered sound-design and music are collapsing which, I argue, is also primarily at the service of spatial presence. This conceptualization aligns with and extends recent discussions suggesting that the boundaries between diegetic and non-diegetic music are also disintegrating, in theoretical terms, if they were ever valid to begin with (Kassabian, 2013; Winters, 2010). So, it is interesting that a film defined by the scientific principles of the vacuum in space, perhaps the most challenging aural environment for encouraging spatial presence, points the way forward to the fusion of sound and music.

Of course, there are consequences associated with this kind of approach. In order for music to move it must remove some of its spatially fixed characteristics. These are typically associated with the perception of real musicians playing real instruments. Audiences find it unnerving, for example, to hear a flute melody moving around an auditorium, because the sound of the instrument automatically conjures mental perceptions of human performers in traditional static performance spaces. *Gravity*'s music editor, Chris Benstead, confirms that one of the stipulations Cuarón gave the music team was that he did not ever 'want to feel like there was an orchestra behind the screen' (Mera, 2014). The result is that there is a great deal of digital manipulation of live recorded orchestral material and the music approaches sound design in its spectromorphological capacity, particularly in the use of what Denis

Smalley would have described as graduated continuant textures (Smalley, 1986, 1997). Orchestral recordings are no longer aurally sacrosanct, they become source materials ready to be transformed. Benstead notes that the composer 'did a lot of editing and reversing of little bits within phrases, in order to delineate it from that more traditional sound' (Mera, 2014). Indeed, one of the central and recurrent aural motifs in the film was created by digitally manipulating and cutting off double bass passages that were recorded separately. Benstead reports: 'We had seven or eight bass players in Abbey Road just doing those little figures' (Mera, 2014). The passages were conceived and recorded specifically so they could then be manipulated in the digital audio workstation.

In terms of process, sound-designers typically record a range of source sounds in order to combine and manipulate them in the creation of the soundscape. Composers (when working with orchestras) tend to treat the recording session as the final realization of the ideas that have been painstakingly mocked-up during the compositional process. On *Gravity* the compositional approach to recording approximates the working practices of sound design by modularizing orchestral recordings and using them as source materials for digital manipulation. It is significant that Price's experience as a music editor seems to have encouraged some of this aesthetic working method.

The film also encourages spatial presence throughout. In fact, the very first sounds of the film are designed to 'suck' the audience into the vacuum of space. As we see a series of titles describing the harsh environmental realism—'There is nothing to carry sound. No air pressure. No Oxygen' and 'Life in space is impossible'—the amplitude of the music and sound gradually increases in all speaker channels, including the LFE, creating an enormous enveloping soundscape that

suddenly falls to absolute silence when we see the first shot of Earth. This powerful aural gesture, which the sound design team called 'the hoover' (Mera, 2014), overwhelms the audience. Benstead reports that the film was especially bold in its use of dynamic range: 'We start out literally at silence with that initial 30–40 second piece, and by the end, in 7.1, I think all the channels hit 0dbfs, and it is really quite a harsh sound as well' (Mera, 2014). The audio-viewer is literally pulled into the film's environment, but unlike similar 'hoover' depressurization-type gestures in *Star Trek* or *Apollo 13*, the audio-viewer experiences the movement themselves rather than through the distance of observing another character. The spatial situation model here bypasses rational process and forces the Primary Egocentric Reference Frame into the mediated environment. Benstead also highlights the fusion of sound and music in this gestural passage: 'Steve came up with that idea, but there is a sound effect element to it and without that it is not what it is. There is a brilliant low end thing in the sound effects and Steve's stuff is in the top of the frequency range, so the marriage in instances like that is absolutely crucial' (Mera, 2014). Figure 1 shows the increasing amplitude in the opening sequence and the sudden drop to silence at thirty-seven seconds using materials derived from the commercially available DVD, which features a 5.1 reduction of the cinema soundtrack.[9]

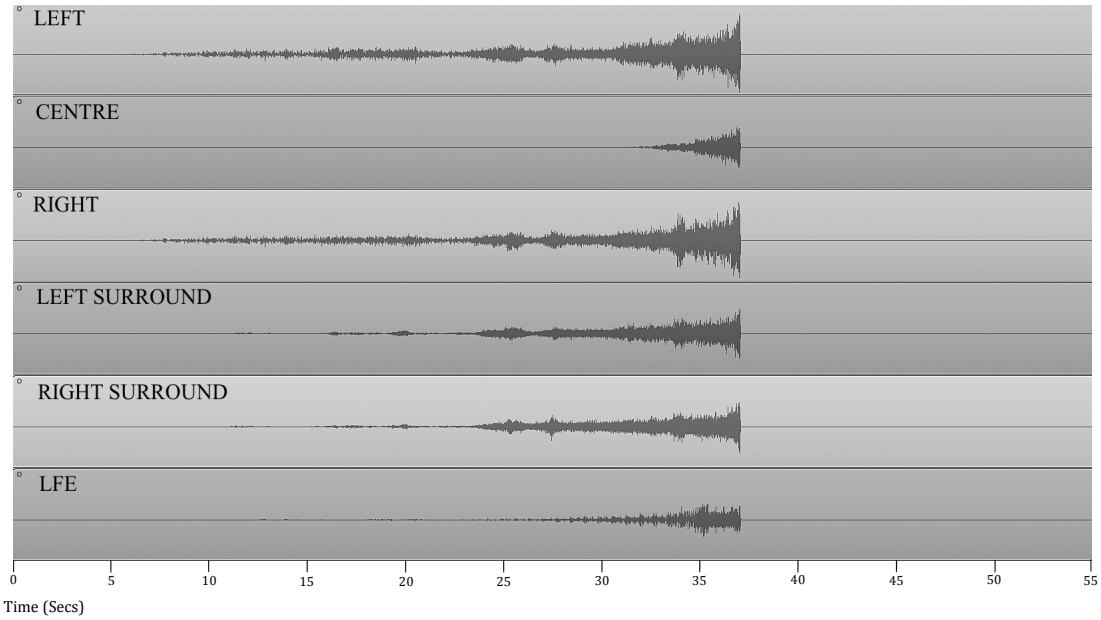

Figure 1. *Gravity*: 'The Hoover', Opening sequence.

Figure 2 shows a surround vectorscope representation of the loudest moment at thirty-seven seconds just before the cut to silence. The ascending concentric rings relate to amplitude bands (-30db rms, -20db rms, -10db rms, and 0db rms.)[10] This diagram provides a stylized visualization of how the surround's audio channels may be perceived by the audience, particularly demonstrating each individual surround channel's presence relative to others. The location of the dot represents the summed surround location of all the surround channel's signals. The significant point is that amplitude is, more or less, equally spread across the auditorium space, generating a complete enveloping sound, represented by the shaded area.

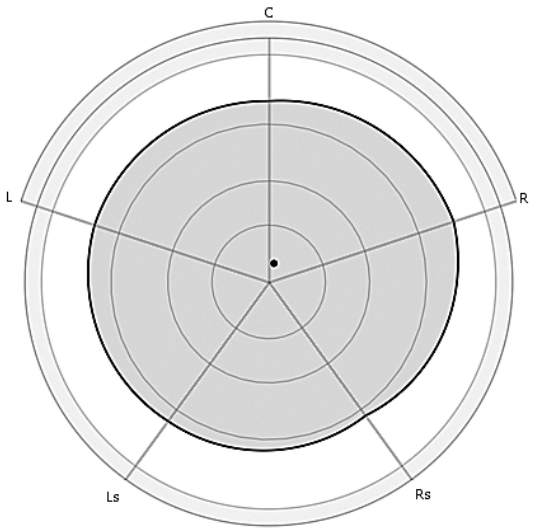

Figure 2. Surround Vectorscope Representation (5.1), *Gravity* Opening c. 37 seconds.

The sound in *Gravity* is not only enveloping, however, it is also dynamic and, as I have already suggested, the music is unusually dynamic. The film's events result from a missile strike on a satellite, which inadvertently causes a chain reaction sending a speeding cloud of debris towards the astronauts who are performing repairs on the Hubble Space Telescope. When we first see the fragments of wreckage approaching the astronauts we do not hear sound effects associated with their movement through space, or of impacts as the debris collides with the Telescope and The Explorer. However, music does enact movement of the debris. We first hear a rising glissando tone, which matches Kowalski's (George Clooney) eye-line as he sees the approaching debris, and gradually transforms from E flat to A flat with an attendant increase in volume. This is further animated by a pan from left to right that matches the directional movement of the debris. In fact, the music moves not only from left to right but around and across the auditorium, in essence a circular shift in energy from the front left to the right surround speaker array. Furthermore, as the glissando tone reaches the high A flat the music also shifts from F minor to A flat

minor, further marking the dramatic significance of the moment. Dynamic music has replaced some of the functions undertaken by sound design.

Later, as Ryan Stone (Sandra Bullock) attempts to disentangle a parachute that prevents the Soyuz from separating from the International Space Station, the debris field completes its orbit and, once again, crashes into the ships. Again no sounds of explosions are heard. The camera reflects the increasingly chaotic movement and, extraordinarily, the 'distorted' orchestral music spins a complete circular 360 degrees. It provides a powerful sensation of disorientation and terror. In this moment, notions of traditional musical sound stage spatialization are completely destroyed. Much as sound design moved to match the visual orientation of the camera in the ultrafield era, here the music moves to represent visual disorientation of the central character and becomes as dynamic as sound design at its most extreme. However, Benstead also notes an important difference and qualifying characteristic of music in motion compared to sound design. Though the music is not as closely tied to 'reality' as traditional sound design, its movement still cannot be random, it must function within a musical framework and, therefore, the panning demands musicality:

> I did it in tempo, almost like balancing a pop record, if something was pinging from left to right surround, I'd have something opposing the other way to fill it in, so it is immersive but it never feels too narrow. There was always a temporal period to those pans. I always felt that it had to obey the rhythm of the sound, it was the rhythm more than anything. (Mera, 2014)

The focus in this section on musical movement could lead us to forget, momentarily, the importance of its function in *Gravity*. Spatial presence is the ability to make audio-viewers believe that they are physically present in the mediated environment. Above all else, *Gravity*'s integration of music and sound in fictional interstellar space and auditorium space attempts to make the audience feel what the

central character, Ryan Stone, feels. Whereas earlier films frequently employed Chion's notion of objective-internal sound in the vacuum, *Gravity* radically plays with point of view and point of audition so that the soundscape moves beyond a purely objective-internal perspective and encourages the audience to *become* Ryan Stone. Music in rotation, for example, clearly embodies Stone's disorientation. Through these devices, the audio-viewer's perceived self-location, perceived possible actions and mental capacities are firmly bound to the character within the mediated space. The soundscape enacts the Primary Egocentric Reference Frame within the mediated environment. Indeed, dexterous and subtle shifts in aural perspective invite us to become Stone as she observes the terrifying emptiness of space from inside her helmet, and also to experience her reaction externally so that we may perceive the environment and empathetically engage with her situation. This is only possible because of the thoughtful and detailed spatial alliance between sound and music.

There are many moments of integration from the film that could be highlighted, but a useful example is when Stone drifts away from The Explorer following the first debris strike. We see her spinning and hear her increasingly panicky breathing, which approaches hyperventilation. Kowalski's voice shifts its location. For example, the successive phrases 'Give me your position' and 'Report your position' are heard primarily in the right front and right surround speakers respectively. We become increasingly aware of the sounds of a heartbeat in the soundscape, much of its energy contained within the LFE. The musical gestures begin to spin in circular waves around the auditorium. Mid-frequency musical delay lines turn into muffled lower frequency textures as the camera travels inside Stone's helmet, her breathing and dialogue becomes more intimate, we experience her desperation. As we travel out of the helmet and eventually see her drift away into the distance, the music again

employs a rising glissando tone and higher-frequency range textures. The heartbeat sounds become more prominent and a sung female voice emerges. Stone says: 'I am off structure and I am drifting, do you copy, anyone…' At this point the soundscape, which has employed dynamic use of the entire speaker array, folds itself into the mono centre speaker channel as Stone's spinning body drifts into the distance. We experience the fear and chaos of the situation as Stone and the soundscape recede into the screen. Benstead notes that mixing was developed initially against 2-D images but then checked in the latter stages of post-production against the 3-D visuals where adjustments needed to be made, because 'pans needed to be a bit deeper, some things needed to be louder or quieter' (Mera, 2014). This sequence demonstrates the harmonious unity between music and sound, using the full range of surround tools available, in order to locate the audio-viewer within the terrifying environment.

It is not uncommon for films set in space to create claustrophobic, lonely, or isolated atmospheres. The emptiness of the void frequently signals emptiness within the characters themselves, something with which they must struggle in a journey of self-awareness. In *Gravity* the audio-viewer is taken with Stone on that journey. It generates moments of genuine silence and exceptionally intimate pseudo-silence that draws the audio-viewer into the narrative world, and it employs radical, dynamic 3-D sound and music that are carefully designed to encourage spatial presence.

Conclusions

Despite my claims for *Gravity*'s groundbreaking status, I am cautious about ascribing it more importance than is appropriate. In many ways, it remains an exceptional example, with a very particular set of circumstances that permitted its bold approach. Nonetheless, the cat is out of the bag, so to speak, and ever-increasing sophistication

in directionality and movement in both music and sound seems like the inevitable next step in the historical evolution of both sound technologies and film aesthetics. Of course, some movies will not require or provide the framework for such audacious treatment. Yet, each era develops films that undertake the boldest experimental approaches and, nonetheless, trickle down to influence general practice. Overall, I suggest that *Gravity* marks a turning point where we begin to see a drift towards 3-D Sound. The gravitational pull of *Gravity* is strong and, I suspect, inexorable. The most significant shift is that music is freed from its traditional sound stage spatialization and, as a result, we move towards more dynamic uses of music in space. Furthermore, the historic divides between music and sound begin to dissolve when the spatial domain articulates the primary relationships between soundscape elements, resulting in a multifaceted, multivalent and integrated soundtrack.

This chapter has examined several kinds of spatial presence. I have argued that the term *immersion* does not accurately account for what takes place when an audio-viewer feels as if they have entered the mediated environment. I have also attempted to demonstrate how cinematic spatial presence works by applying Wirth et al.'s model to various challenging examples. It is not simply the nature or scale of the technology that is key, but rather the way it has been developed within a clear aesthetic framework that results in more effective spatial presence experiences. At the very least, I hope to have demonstrated that spatial presence is more significant than film sound scholars have acknowledged thus far. By showing the continuous evolution and negotiation between sound and music within the cinematic space vacuum, I have also attempted to demonstrate how representations of the interstellar space have been at the centre of aesthetic challenges relating to notions of spatial presence in cinema. We have witnessed silence, pseudo-silence and dynamic sound in various developing

forms. The scientific reality of silence within the space vacuum has resulted in representational experiments that have constantly sought to help us leave our own world behind.

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[1] It is also worth noting that within virtual reality studies there has been detailed discussion about the appropriateness of the use of the terms *presence* and *telepresence*. See Bracken and Skalski (2010) for an overview of these debates.

[2] Dolby Atmos is the name of a surround sound technology announced by Dolby Laboratories in April 2012. It delivers a supported soundtrack to conventional speakers in the cinema and also to speakers in the ceiling to give extra height to the soundscape.

[3] Montgomery Scott, or 'Scotty', never actually said: 'You cannae change the laws of physics' in the *Star Trek* television series. In episode 1, season 1 'The Naked Time' (1966) Scotty clearly states: 'I can't change the laws of physics! I've got to have thirty minutes!' The preference for the Scottish vernacular has become a recurrent meme/cliché, which was at least partially reinforced by The Firm's parody song 'Star Trekking' (1987).

[4] A Roadshow Theatrical Release, sometimes also known also as a Reserved Seat Engagement, describes the Hollywood studio practice of pre-release in state-of the-art cinemas in large cities for a specific period of time before nationwide general release. The practice had largely ended by the early 1970s. See Holston, K. R. (2013).

[5] This spatialization was not so heightened in the Subsequent 5.1 mix, in the 1990s.

[6] The original seventy-millimetre release, like many Super Panavision 70 films of the era, was advertised as being in 'Cinerama' in theatres equipped with special projection optics and a curved screen. In standard cinemas, the film was identified as a seventy-millimetre production. The original release of *2001: A Space Odyssey* in seventy-millimetre Cinerama with six-track sound played continually for more than a year in a handful of venues, and for one hundred and three weeks in Los Angeles.

[7] This was subsequently renamed *Star Wars Episode IV: A New Hope.*

[8] The technology was first used in Disney Pixar's *Brave* (2012). At the time of writing there are currently 300–600 Atmos-enabled theatres. At the end of 2014 Dolby announced that Atmos would be available for home theatres.

[9] It is worth noting that it was not possible to access the 7.1 or the Atmos mix materials, partly because of commercial sensitivity. It remains an obstacle to detailed sound analysis, particularly film surround sound, that such materials are not archived or easily available for scholarly analysis.

[10] Db (FS) is Decibel Full Scale, which refers to digital full scale readings. Zero is the top of the scale and cannot be exceeded. Db (RMS) is Root Mean Squared and refers to the average level, not the peaks which can be much higher than the average level.