



Riding the wave: Science fiction media fandom and informal science education

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Abstract

Popular entertainment media about scientists can inspire interest in real-world science. This has led science communicators to develop books, television shows, and traveling exhibits that tie informal science education to works of fiction, framing their tools as “the real science” of fictional universes. Scientists and science writers involved in these projects argue that science fiction, in particular, creates a sense of wonder that can fuel the desire to learn more about the world and even inspire people to pursue a science career. Science fiction does not have to present realistic science in order to be used for informal science education, but science communicators should define the separation between real-world and fantastic science. This paper examines a book and two documentaries that attempted to portray the “real science of” the television series *Doctor Who* and analyzes how these works establish credibility for both the science and entertainment content, as well as how aspects of the fictional world of *Doctor Who* are incorporated into the educational content.

Keywords: *entertainment, fandom, media studies, science communication, science fiction*

Popular interest in entertainment media about scientists can, in turn, inspire interest in real-world science. This interest has led science communicators to create books, television shows, and traveling exhibits that tie informal science education to works of fiction, framing them as tools that explore the “real science of” a fictional universe. Science communicators (i.e. scientists, science writers, and others involved in presenting science to a non-expert audience) argue that science fiction, in particular, creates a sense of wonder that can fuel the desire to learn more, or even to pursue a science career (O’Keeffe, 2013).

Before going on to write his own science fiction novel, *Contact* (1985), scientist and science popularizer Carl Sagan recalled being inspired to think about science by the fiction of Edgar

Rice Burroughs, wondering if it would ever “be possible—in fact and not in fancy – to venture with John Carter to the Kingdom of Helium on the planet Mars” (Sagan, 1980, p.111). Other scientists, including physicists David Brin and Gregory Benford, have turned to writing science fiction. Brin estimates that 10% of science fiction writers come to the field with a background in science (N. Jones, 2010).

In addition to writing science fiction of their own, scientists who see value in fostering connections between science fiction and real-world science can do so through media productions. The documentaries analyzed in this article feature physicists Jim Al-Khalili, Maggie Aderin-Pocock, Brian Cox, and Michio Kaku. Why would prominent scientists get involved with projects based on

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fantastical, make-believe science? It may be because of their own feelings about the inspiration that science fiction can foster. Kaku recalled his early consumption of and affection for science fiction: “I was mesmerized by the possibility of time travel, ray guns, force fields, parallel universes, and the like. Magic, fantasy, and science fiction were all a gigantic playground for my imagination” (Kaku, 2008, p. ix). In considering the potential for commercial space exploration and space tourism, Aderin-Pocock sees science fiction as a window to possible futures, noting that “science fiction can become science reality, and really quite quickly” (Maggie Aderin-Pocock goes boldly, 2014, para. 2.). More wondrous concepts from science fiction can also inspire young scientists. Al-Khalili argues that the concept of time travel, in particular, is “just the topic to fire the imagination... it provides an ideal opportunity to introduce some of the ideas behind our most beautiful and fundamental theories about the nature of space and time” (Al-Khalili, 2003, p. 14).

This paper will first generally consider research about the portrayal of real-world science in fictional media, and then focus on three recent productions—one book and two British Broadcasting Corporation (BBC) television specials—that use the popular and long-lived program *Doctor Who* as a basis for informal science education.

Portrayals of Science in Science Fiction

Much of the research on how science appears in entertainment media has focused on how scientists are represented as characters. Research in this article draws on theories and concepts such as cultivation theory (Gerbner, Gross, Morgan & Signorielli, 1985), which explores how cultural values are learned through media exposure, or the

role of character identification on the viewer’s experience (e.g. Steinke, Applegate, Lapinski, Ryan, and Long, 2012). Researchers have also examined scientist portrayals in terms of gender (e.g. Flicker, 2003; Jackson, 2011; Kitzinger, Haran, Chimba & Boyce, 2008; Steinke, 2005) and other demographic factors such as social class (R. Jones, 1997) or stereotypes about physical traits such as unkempt hair (e.g. Frayling, 2005).

Many scientists, science communication scholars, and science educators are concerned about the potential influence of “bad science” in entertainment media because they believe inaccuracies presented on-screen can undermine public science literacy (e.g. Perkowitz, 2007; Szu, Osborne, & Patterson, 2016). Barnett, et al. (2006) suggest that these concerns are justified; they found that students exposed to a single viewing of the science fiction disaster film *The Core* had more misunderstandings of concepts from earth science than those who did not watch the film. To examine the impact of science fiction on science education, both scholarly and popular sources have addressed the extent to which works of fiction convey scientific information accurately (e.g. Glassy, 1997; Lambourne, Shallis, & Shortland, 1990; Rogers, 2007). Is the information presented accurate when scientific principles are explained, when tests are conducted, when a scientific theory is used as the basis for saving (or destroying) the world? Do futuristic technologies represented on-screen operate according to the known laws of physics? Very often, the answer to these questions is no.

To address this dilemma, some scientists have chosen to involve themselves in the process of media production by serving as science consultants on films and television shows. Interview-based research has explored the work

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of science consultants in Hollywood (e.g. Frank, 2003; Kirby, 2003), providing another perspective on the relationship between fictional and real-world scientists. By trying to help filmmakers get the facts right, scientists who work as science consultants may hope to influence public opinion or educate viewers. Kirby found that many science consultants “felt it was their ‘duty’ [...] to impart knowledge to an uneducated public” (2003, p. 266).

While science consultants are concerned with accuracy in how science is communicated to the public, some educators take a broader view, arguing that fictional media do not have to feature accurate science in order to be used as educational tools. Even media with little or no overt science content can be used for educational purposes. Perales-Palacios and Vilchez-Gonzales (2005) examined the potential for using cartoons as teaching aids in physics classes and found that physics lessons based on how physical principles are violated in cartoons encouraged student motivation, provided a useful basis for analyzing physical phenomena, and promoted critical thinking. Other scholars have taken the position that comparing accurate and inaccurate portrayals of science is valuable in and of itself. Barnett and Kafka argued:

When showing movie scenes, it is important to expose students to a variety of clips that represent both good and bad science, and particularly those scenes that attempt to create a scientific reality that is in contrast to currently accepted scientific beliefs. By examining a variety of movie scenes, we found that students will be in a better position to evaluate the scientific validity of science as predicted in film. (2007, pp. 34-35)

Another strand of research about science in entertainment media considers not the accuracy of the scientific content, but its potential to inspire. Michio Kaku’s aforementioned description of his early experiences with science fiction as a “playground for [his] imagination” (Kaku, 2008, p. ix) embodies this perspective. In popular sources such as magazines and websites, it is easy to find anecdotes about role of science fiction in inspiring scientists to pursue science careers and to tackle particular areas of research (e.g. Howard, 2014; McLaren, 2013). A few studies exist about such inspiration at the personal level (e.g. Fleischmann & Templeton, 2009; O’Keeffe, 2013). The European Space Agency (ESA) decided the inspirational nature of science fiction was worthy of serious study and commissioned a report to identify science-fictional technologies with important, real-world potential (European Space Agency, 2001).

While researchers such as those working with the ESA see value in exploring the potential found in the implausible ideas of science fiction, scholars with a traditional approach to science communication that emphasizes the “public understanding of science” orientation believe appropriate science communication is intended to foster informed citizenship. These scholars might consider books or documentaries about the “real science” of *Doctor Who* to be part of a potentially dangerous trend that erodes the distinction between actual science and fictional science. Barnett and Kafka (2007) developed an interdisciplinary college course utilizing media clips specifically to counter the entertainment model that “often creates misunderstandings regarding the nature of science and leads to a blurring between fact and fiction” (p. 31). While they acknowledge the potential of science fiction movies to inspire students, Barnett and Kafka



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are more concerned about how realistic-looking special effects and the overall visual appeal of SF films will encourage students to accept uncritically inaccurate science concepts from the movies. Nowotny (2005) suggested that “selling science as sexy has gone too far, amusing as it may be to explain the magic in Harry Potter in scientific terms [...] Sexy communication is not going to be enough to inform good decision-making” (pp. 1117-1118). Despite these critiques, science communicators continue to try to harness the broad appeal of science fiction by using popular media as a tool to increase science literacy.

Informal Science Learning & Media Tie-Ins

Broadly, informal science education is any kind of science education that occurs outside of a school environment (Stockmayer, Rennie, & Gilbert, 2010). Here, I am concerned with informal science learning that is connected to media consumption. Some of the common components of informal science education that are relevant in the context of learning through mediated texts are that it is learning that is not restricted by age, that takes place outside of a school setting, that is voluntary and self-directed, and that is not driven by a formal curriculum imposed from the outside (Stockmayer, Rennie, & Gilbert, 2010).

There is a growing awareness among scholars outside of media and film studies that entertainment media can play a critical role in the development of attitudes about and interest in the sciences and that more research is needed in this area. A National Research Council report on informal science learning found that “representations of science in the popular media have rarely been studied in the context of learning, yet it seems obvious that most Americans are more familiar with fictional scientists like Dr. Frankenstein

or the medical staff of ER than recent Nobel laureates” (National Research Council, 2009, p. 259). Although interest in turning to science fiction and other forms of entertainment media for science education is positioned as a recent development, one could argue that the production of educational science materials based on popular entertainment predates the era of mass media broadcasting. Arabella Buckley’s 1879 children’s book, *The Fairy Land of Science*, is one example of several Victorian-era efforts to expose children to scientific ideas through fairy tales. These works strove to make science texts both “instructive and amusing” as part of a “melting pot of facts and fantasy that brought education and entertainment together” (Keene, 2012; see also Keene, 2015 for an in-depth look at the genre).

Similarly, authors of today’s media tie-in books aim to educate readers by utilizing the inspirational qualities of science fiction and the audience’s affection for visual media, as evidenced by a surge in “real science of” projects that began with Lawrence Krauss’s successful *The Physics of Star Trek* (1995). Krauss, a prominent physicist, acknowledged that *Trek*’s popularity is the reason it may serve as a useful tool for exposing people to physics, but he implied some frustration at the enthusiasm with which the general public seems to readily absorb fictional, rather than real, science. At the same time, Krauss included the show’s catch phrases in his book to establish himself as a *Trek* “insider” as well as a respected scientist:

When we consider that the Smithsonian Institution’s exhibition on the starship Enterprise was the most popular display in their Air and Space Museum—more popular than the real spacecraft there—I think it is clear that *Star Trek* is a natural vehicle for many

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people's curiosity about the universe. What better context to introduce some of the more remarkable ideas at the forefront of today's physics and the threshold of tomorrow's? I hope you find the ride as enjoyable as I have. Live long and prosper. (1995, p. xvi)

Lawrence followed *The Physics of Star Trek* with a sequel, *Beyond Star Trek* (1997); other authors, perhaps inspired by Lawrence's success, also tackled the fictional science of *Twister* (Davidson, 1996), *Jurassic Park* (DeSalle & Lindley, 1997), *The X-Files* (Cavelos, 1998), *CSI* (Ramsland, 2001), and superheroes (Kakalios, 2005).

Such analyses of fictional science have not been limited to books; there have been a number of touring science center exhibits related to mass media products as well. *Star Wars: Where Science Meets Imagination* was developed by The Museum of Science (Boston) and toured from 2006-2014 (Museum of Science, 2016). Global Experience Specialists' *Harry Potter: The Exhibition* began at the Museum of Science and Industry in Chicago in 2009 and has been booked at other science centers, as well as non-science venues; most recently the exhibit was at the Brussels Expo in September 2016 (Global Experience Specialists, 2016). *Jurassic World: The Exhibition* developed by Imagine Exhibitions, Inc., premiered at the Melbourne Museum in March of 2016 and is scheduled to be at Philadelphia's Franklin Institute in November of 2017 (Franklin Institute, 2016).

Credibility

Science popularization is a broad project that encompasses journalism, websites, museums, television shows, books, blogs, and films. In classic conceptions of science communication, it is assumed that the process of popularization involves

the communication of information from "scientists" to "the public," but this limiting binary reduces the ability of science communicators and the general public to understand the actual ways that science operates in culture (Hilgartner, 1990). In contrast, current approaches to science communication take into account the differing backgrounds, experiences, and knowledge sets of different publics, allowing for new forms of collaboration between scientists and the general public, as well as between scientists and government, scientists and funding institutions, and among different branches of science (Scheufele, 2013). These collaboratively-based models of science communication could be expanded to include different engagements with media texts, including considering how "real science of" projects fit within the domain of science communication.

What model of science communication do "real science of" texts follow? These texts tend to make the basic assumption that the reader lacks scientific knowledge and will be unable to distinguish fact from fiction in entertainment media. At first blush, these works may seem to utilize a traditional "deficit model" which assumes science literacy is the main factor driving the public's attitudes toward science. In the deficit model, if science communicators can provide the public with facts, the public knowledge deficit will be reduced and attitudes towards science improved. Scholars of science communication have long criticized the limitations of the deficit model and continue to grapple with its enduring appeal among scientists, journalists, and the general public (e.g. Scheufele, 2013; Sturgis & Allum, 2004).

Strict adherence to the deficit model would emphasize only real science in these educational media tie-ins and ultimately fail to find any value

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in the science fiction source material, thus failing also to inspire the target audience of these texts. A more appropriate model for conveying information about the science behind science fiction might be the “contextual model” of science communication. Brossard and Lewenstein (2010) argued that using the contextual model acknowledges that people “process information according to social and psychological schemas that have been shaped by their previous experiences, cultural context, and personal circumstances” (p. 14) and that media representations play a role in this process as well.

I argue that the target audience for works about the “real science” of fictional television shows is one that is highly interested in the source material, that this audience is, in large part, constituted by people who are fans of the material, at least to some degree. If the “real science of” products are intended to educate fans about true science behind the media they readily consume, it makes sense to position these educational media tie-ins as fan-oriented texts. An in-depth discussion of the shifting meaning of the word “fan” is beyond the scope of this article, but when I say “fan-oriented”, I mean to emphasize the way that the producers of such texts acknowledge and speak to an active audience that is ready to grapple with real-world concepts introduced by cherished fictional texts. Jenkins (2007) emphasized that in an interactive, digital, and convergent media environment, “fan culture” is becoming an important part of mainstream culture. Even casual viewers of a television program may visit a website about the show, comment on a blog, and share or even create a meme based on the show. These are all “fannish” activities, even when performed by a person who will never attend a science fiction convention, which some might consider a key factor in defining one

as a “fan”. Treating the “real science of” products as part of a fan culture is simply an acknowledgment that, for fans, the science is imbued with greater meaning by being filtered through the fictional work with which they are already so familiar. By tying the educational material to a valued text, the potential for both inspiration and learning may be enhanced.

To employ the contextual model, and utilize the value of fannish interest in the work, the science communicators’ strategy needs to include a demonstration that fans’ cultural contexts are understood and valued. To be convincing as a popular science text, then, these “real science of” products need to establish credibility regarding both the science and the fiction they address. Credibility regarding science is established through traditional means—noting that the author has held scholarly positions, published research or other popular science texts, and engaged in scientific research. Establishing legitimacy within context of a fan-oriented text can be trickier.

Throughout *The Physics of Star Trek*, Krauss indicated his knowledge of the lore of *Star Trek* fandom, thus providing a successful example of how to establish credibility as a fan without diminishing credibility as a scientist. In addition to using the phrase “[I]ive long and prosper” in the book’s introduction, he referred to fans as “*Trekkers*” rather than the more widely known—but sometimes insulting—term “*Trekkies*”. Krauss cites specific *Star Trek* episodes by title, demonstrating a broad knowledge about the show and an understanding that such details matter to his readership. The credibility of *The Physics of Star Trek* in both the world of physics and that of *Star Trek* fandom is further established by its forward, which was written by prominent



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physicist Stephen Hawking. Hawking's efforts to popularize science have not only made him one of the most recognizable names in science, but also landed him a cameo role on "Descent," an episode of *Star Trek: The Next Generation* (Echevarria & Singer, 1993), cementing his place in *Star Trek* fan culture. His forward to Krauss's book ended with the inspirational lines, "[Today's] science fiction is tomorrow's science fact. The physics that underlies *Star Trek* is surely worth investigating. To confine our attention to terrestrial matters would be to limit the human spirit" (Krauss, 1995, p. xiii).

Science and Fiction

If the media product features fantastical science, how is the fictional narrative incorporated into an educational format? The "real science of" products must distinguish fact from fiction, while also drawing meaningful connections between these two realms.

Traveling exhibits—which are essentially science center-style exhibits with a media nexus—exemplify the intersection of fictional texts and informal science learning. These exhibits examine the science related to popular media products such as *Star Wars*, *Indiana Jones*, *CSI*, and *Harry Potter*. Like "real science of" books and programs, these exhibits must address how to incorporate fiction while teaching facts to visitors. The traveling exhibit *Narnia: The Exhibition*, produced by Global Experience Specialists, ran from 2008 to 2012 and offered visitors to science centers and other venues visitors the chance to learn about science and Narnia (Global Experience Specialists, 2012). C.S. Lewis's seven-book fantasy series has enchanted generations of readers since the publication of the first book in 1950, and recent film adaptations offered fans new ways to engage with these classic stories. Both the original books and the movies,

however, are firmly rooted in the world of fantasy; crafting a science center exhibit from the story of Narnia presented a significant challenge for its designers.

In a photographic and positive review of *Narnia: The Exhibition* during its stop in Louisville, Kentucky, Nash (2011) explained how the designers tried to connect the individual displays with a broader discourse of science. One display featured a fossilized bear tooth shown alongside a couple of lines of paleontological information, including that the fossil was from the Pleistocene Era and that it had been found in Wyoming's Green River Formation (Nash, 2011, para. 12). There was also some information about climate science, with informational signs about the dangers of deforestation and a display about climate change called "Winter in July." Nevertheless, much of the exhibit featured costumes, props, and set recreations on display without apparent educational aims. One exhibit featured a replica ice throne used on set; in the caption of her photograph of the ice throne, Nash wrote, perhaps with a touch of humor, "Science tie-in: Real ice palaces do exist" (2011, para. 11). In short, the science content was unconvincing and the relationship between the science and the fantasy was thin, lending support to Nowotny's (2005) concern that attempts to make science "sexy" by emphasizing its connections to popular media could undermine rather than contribute to science literacy.

Are media tie-in exhibits and books which feature science doomed to exist only as amusing yet shallow attempts to market a "sexy" and potentially meaningless representation of science? Such a perspective foregrounds the financial interests behind the books, shows, and exhibits that attempt

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to link science education to entertainment media. *Narnia: The Exhibition* and similar projects are known as “blockbuster exhibits” intended to draw large crowds to the science centers at which they are programmed (Lui, 2011). Some argue that their role in informal science education is not to educate, but to get patrons in the door, perhaps in the hope that they will view other exhibits as well (Smithsonian Institution, 2002). Because they need to appeal to the broadest audience, the blockbuster exhibits do not speak to the fan community directly. Nevertheless, the *Narnia* exhibit illustrates some of the challenges that any “real science of” product could encounter, namely that it can be difficult to present engaging, real-world science information while staying true to a fantastic narrative.

To succeed as both a fan text and a text of science communication, these creations need to demonstrate an authentic and responsible treatment of both the fictional and the non-fictional content. The *Narnia* exhibit made only tenuous connections between the narrative and the science concepts. Krauss’s “real science of” *Star Trek* books were successful because they tapped into the belief fans already held about the source material: that *Star Trek* had something important to say about the future of science and technology, and even that it has served as inspiration for real-world science (J. Jones, 2005).

Key aspects of the source material need to be incorporated into the discussion of real-world science, because they can help authors create an authentic connection between science and science fiction in an educational context. Such incorporation does not depend on the accuracy of the science content in the source material; rather, it must reflect the perspective of the curious viewer wondering how an interesting aspect of a

fictional story compares to real-world science. In his chapter on *Star Trek*’s transporter technology, Krauss did not simply mention the existence of the transporter and call upon broad cultural familiarity with the phrase “Beam me up, Scotty!” Instead, he turned to the whole canon of *Star Trek* to examine whether the transporters move the actual matter of an individual’s body, or if the transporter encodes the person as pure information—a debate Krauss summarized as “atoms or bits?” (Krauss, 1995 pp. 65-83). Speaking to his knowledgeable reader, Krauss wrote:

You might wonder why I make this point, since the *Next Generation Technical Manual* describes the process in detail [...] [the] transporter [...] apparently sends out the matter along with the information.

The only problem with this picture is that it is inconsistent with what the transporter sometimes does. On at least two well-known occasions, the transporter has started with one person and beamed up two. In the famous classic episode “The Enemy Within” a transporter malfunction splits Kirk into two different versions of himself, one good and one evil [...] If a transporter carries both the matter stream and the information signal, this splitting phenomenon is impossible. (Krauss, 1995, pp. 67-68)

Having established both the contradictions within the fictional universe and his own familiarity with that universe, Krauss examined transporter technology from the vantage point of real science, touching on “quantum mechanics, particle physics, computer science, Einstein’s mass-energy relation, and even the existence of the human soul” (Krauss 1995, p. 83) in the process. The fact that he ultimately concluded that transporters will remain



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the stuff of fiction does not diminish the sincerity of the chapter; what makes this discussion work is that he dealt with the source material as something worthy of thoughtful consideration. Rather than dismissing the idea of transporters as an impossibility, Krauss conducted a systematic consideration of how they would operate, using this thought experiment to introduce a number of science topics. In this way, he emphasized the value of fantastical science in the context of informal science education.

“Real Science” and *Doctor Who*

The television series *Doctor Who* has a strong fan base and the show’s narrative offers great potential for significant science content. Consequently, there are several “real science of” media tie-ins focused on it.

Produced by the BBC, *Doctor Who* has an elaborate canon, as its first run occurred between 1963 and 1989, and the new series has been ongoing since 2005. The show’s protagonist is referred to as “The Doctor”—not, as the series name would indicate, “*Doctor Who*.” To date, twelve different actors have played the role. The Doctor is a time-traveling alien from a race called the Time Lords. Like all Time Lords, The Doctor has the ability to regenerate, taking on a new physical appearance (and conveniently providing the narrative justification for the casting changes). The Doctor’s time ship is generally trapped in the shape of a London police box and is called a Tardis, which stands for “Time and Relative Dimension in Space.” The Tardis is much larger on the inside than it appears from the outside, leading some to hypothesize that it is actually a doorway to a wormhole, new dimension, or an alternative universe.

For each of the “real science” productions, I will

consider the question of credibility—how both scientific authority and fannish authenticity are established, along with evaluating how science concepts are integrated with the fictional source material. This analysis includes one book and two hour-long television specials; comparison across media formats presents some inherent problems—obviously, the hour-long television specials have less room to provide detailed scientific explanations than a 342-page paperback. My purpose is not to compare these texts with respect to the volume of science-based information; rather, I am interested in how the producers of these works navigate the tension between fact and fiction in a genre devoted to explaining one through the lens of the other.

The Science of *Doctor Who* (2007)

In 2007, science writer Paul Parsons published an unofficial guidebook to the science of *Doctor Who*. This book, *The Science of Doctor Who*, is divided into four main sections that weave aspects of *Doctor Who*’s lore—its aliens, its technologies, and its cosmology—with discussions of relevant, real-world science research. The first section is “The Doctor in the Tardis,” which covers some fundamental aspects of the show’s premise, including the personality and biology of the alien Doctor and the basics of the Tardis as a time-traveling machine. The second section, “Aliens of London, and Beyond”, features individual chapters discussing many of the most memorable aliens from the show. The third section, “Robot Dogs, Psychic Paper and Other Celestial Toys”, covers the technological capabilities and inventions seen on-screen. The fourth section, “Mission to the Unknown”, deals with the cosmology of *Doctor Who*. Individual chapters within each of these sections examine specific elements of the series and analyze the relevant scientific research those

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elements evidence. Given that Parson's book is "unofficial"—that is, not published by the BBC—its front cover lacks visual cues that would attract *Doctor Who* fans and establish its legitimacy. There are no trademarked images or typefaces, no logo from the show itself, no image of the Tardis, and no photographs of any of the actors or recognizable trademarked elements of the show. This could be a barrier to reaching the book's target market. Instead of trademarked elements, the cover image of *The Science of Doctor Who* is an abstract blue design with a shadowy figure falling toward the design's center, evoking the falling Tardis and "wormhole-like" animation that features prominently in the show's opening credits. *The Science of Doctor Who's* cover features bulleted text identifying some of the topics covered in the book that (apparently) cannot be pictured: the Daleks, the Tardis, the Time Lords, and the Doctor's robotic dog, K-9. At the bottom of the cover a quote from Colin Baker, one of the actors who has played The Doctor in the television series, vouches for the book's indispensability. These textual elements help to anchor the book as a text for fans, despite the missing visual depictions of key symbols from the show.

The cover of *The Science of Doctor Who* also promotes the fact that the forward was written by science fiction author and science writer Arthur C. Clarke. Although best known for his science fiction, Clarke published a number of nonfiction books on space travel and other science topics relevant to science fiction. As such, his introduction serves to establish the relevancy of Parson's book to the intersection of science fiction and science fact. However, unlike *Star Trek* fan and guest star Stephen Hawking who contributed to Krauss's *The Physics of Star Trek*, Clarke is not interested in *Doctor Who*. He knew "many die-hard fans" and

noted that "some have gone on to become top scientific experts in their chosen fields" (Parsons, 2007, p. xi). Rather than discussing *Doctor Who* itself, much of Clarke's forward to Parson's book is devoted to the debate about time travel—whether a time-travel story such as *Doctor Who* can be classified as "science fiction" or if it must be relegated to "fantasy". Clarke takes the latter position: "Science fiction is something that could happen—but usually you wouldn't want it to. Fantasy is something that couldn't happen—though often you wish it would" (p. xii). Yet ultimately, Clarke agrees that a science writer exploring a "fantasy-based realm" for scientific concepts could be rewarding for those interested in both science and science fiction.

In part, Parsons establishes the credibility of *The Science of Doctor Who* by referencing Krauss's *The Physics of Star Trek*. In his own preface, Parsons explicitly discusses this earlier text by Parsons, hoping that the reader will "find that [he has] done similar justice to the *Doctor Who* universe" as Krauss's did with his treatment of *Star Trek*. Parsons also outlines his qualifications as both a science writer and a fan of *Doctor Who* in the preface, writing, "I've been a *Doctor Who* fan since the early years of Tom Baker, a science writer and journalist since 1996, and a keen science student and post-grad researcher for almost a decade before that" (Parsons, 2007, p. xv). By treating all of these credentials as equally important, Parsons demonstrated his understanding of how the balance of science and fiction made Krauss's book successful. Parsons also emphasized that he contacted a variety of scientists as part of his research for *The Science of Doctor Who*, and that these scientists contributed information that appears throughout his text.



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The organization of the book is respectful of both the show and the science. Each short chapter takes on a concept from the show—either a running theme or an incident from a specific episode—and describes relevant research on the topic. The chapter on regeneration, for instance, describes how The Doctor has been able to defy death through regeneration, then goes on to present research about the freshwater hydra, a small organism able to repair and regrow damaged body parts (Parsons, 2007, pp. 47-54). Chapter 16 covers an alien monster called the Krynoid, a hostile and carnivorous plant. This chapter includes information on the Venus flytrap, research on “plant neurobiology” (Parsons, 2007, p. 156), and genetic research into the possibility of “human-plant hybrids” (p. 159).

Of the three “real science” of *Doctor Who* productions being examined, Parson’s book is the one that most closely follows the deficit model of science communication. Perhaps because this text does seem to embody the deficit model, this is also the one of the three examples that explicitly denies doing so. In *The Science of Doctor Who*’s conclusion, Parsons writes:

It’s probably somewhere around here too that I’m meant to say something profound about the noble pursuit of science [...] This book was written first and foremost to entertain, to boost enjoyment of the show, and to answer questions that it may have raised in the minds of intelligent fans. I hope I’ve fulfilled those aims. If I did manage to educate anyone along the way, I sincerely apologize. (Parsons, 2007, p. 317)

Here, Parsons denies that the aim of the book is to teach the reader a little bit of science and

offers a tongue-in-cheek apology for doing so inadvertently. Although the text is successful in presenting a wide range of real-world science research through the lens of *Doctor Who*, “entertainment” and “education” are still presented as forces that may be in conflict, rather than mutually beneficial elements of the text.

The Science of *Doctor Who* (2012).

In 2012, BBC America aired an officially-licensed television special about *The Science of Doctor Who* (O’Connor, 2012), which, unlike Parsons’s unofficial 2007 book, was able to make extensive use of the BBC’s copyrighted materials. The one-hour special *The Science of Doctor Who* features interviews with actors and other media personalities as well as with scientists. It is peppered with segments entitled “Let’s Ask the Scientist” as well as short clips from various *Doctor Who* episodes. No interviewer is featured on-screen; the documentary identifies interviewees when they are first introduced by including their name and job titles on the screen; clips from their interviews are split up and interspersed throughout the episode. Over the course of the special, the diverse group of interviewees discusses science-oriented themes from *Doctor Who*. When interviewees mention specific moments from *Doctor Who*, short clips from the episodes in question are intercut with the interviews. This provides a frame of reference for viewers who may not be familiar with or who may have trouble remembering the specific scenes being invoked. After each thematic segment, some of the interviewees vote on how likely it is that the science-fictional theme or technological advance will become reality; not all interviewees vote after each segment. Represented by Tardis icons at the bottom of the screen, the votes are presented on a scale of one to five, with



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one indicating that that particular advance will be impossible for humanity to achieve and five indicating that it will definitely occur. Votes from scientists and non-scientists are weighted equally, ignoring the potential influences of scientists' specific disciplines.

The variety of interviewees includes scientists, actors, comedians, and members of the show's production staff. By featuring actual snippets of *Doctor Who* episodes as well as interviews with a variety of media personalities, *The Science of Doctor Who* foregrounds entertainment value over science education. At the same time, one of the documentary's interviewees, scientist and science popularizer Maggie Aderin-Pocock, noted that interest in *Doctor Who* can lead to interest in the sciences, proclaiming, "Watching *Doctor Who* made me the space scientist that I am today!" (O'Connor, 2012). The other scientists interviewed in *The Science of Doctor Who* also articulated their familiarity with and interest in the series. Nowotny's (2005) concern that media tie-in products erode the important barrier between science and non-science can also be observed here in O'Connor's *The Science of Doctor Who*, which makes little effort to privilege the knowledge of scientists over that of actors and comedians.

Although this approach may undermine the program's science legitimacy, this style of presentation—that is, treating the opinions of scientists and non-scientists as of equal merit—does have an advantage; it suggests that science and difficult concepts are nothing to fear and they are easily accessible to anyone—scientist or not—who wants to learn about them. O'Connor's *The Science of Doctor Who* presents viewers with scientists, actors, and producers who are all interested in and grappling with wild concepts

from *Doctor Who*, which, as the non-scientists acknowledge, is not an easy thing to do when it comes to concepts such as understanding space-time.

The Science of Doctor Who with Brian Cox (2013)

The Christmastime special *The Science of Doctor Who with Brian Cox* (Cohen & Harrison-Hansley, 2013) features a lecture by well-known physicist and science popularizer Brian Cox, delivered before a live audience at the Royal Institution of Great Britain (RI). The RI was founded in 1799 and is known for supporting public engagement with science through a variety of initiatives, including a Christmas lecture series (founded in 1825); these public lectures are intended to present a scientific topic to a general audience, with special attention paid to young people (Royal Institution of Great Britain, n.d.).

Cox introduces his talk by discussing the RI Christmas lecture of 1860, Michael Faraday's "The Chemical History of the Candle." Cox is speaking at the Royal Institution during the holiday season; by drawing on the history the Christmas lecture and its role in science popularization, Cox establishes credibility for his own lecture. He says, "This building, this lecture theatre, has a past that is inextricably bound up with our present and our future. Not only through the great discoveries that have shaped our scientific civilisation, but also through the countless generations of children and adults alike who've been inspired, by lectures given in this theatre, to explore nature and to find new worlds to conquer" (Cohen & Harrison-Hansley, 2013).

Cox's summary of Faraday's lecture itself also establishes a narrative structure for his

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presentation. Cox admits that if he had access to a working time machine, he would like to visit the RI in 1860 so he could see Faraday's lecture in person; he returns to this fantastical goal several times to illustrate various concepts, such as the speed of light and the geometry of spacetime.

As in the 2012 television special, this BBC-produced program intersperses scientific information with fictional content about *Doctor Who*. In a creative twist, however, this program does not use existing clips from the show. Rather, *The Science of Doctor Who* with Brian Cox features a series of scripted scenes that show conversations between Cox and the 11th Doctor (played by Matt Smith). The two men banter in the Tardis, discussing matters of time travel and space exploration, and the Doctor invites Cox to take the position of his assistant. Thus, Cox's legitimacy to speak on matters related to *Doctor Who* is not based on childhood fandom or any particular knowledge of the show; Cox is given approval within the fictional universe by The Doctor himself. Through these scenes, a fictional "Brian Cox" character is created, one who can visit with the Doctor and travel with him. Suddenly, Brian Cox is not merely explaining the science of *Doctor Who*—he may be the closest thing that we have to a real Time Lord, or at least a companion.

Unlike the more casual discussion of time travel that appeared in O'Connor's *The Science of Doctor Who* (2012), Cox's content is more narrowly focused on the physics necessary to discuss the possibility of time travel. This refined scope allows Cox to undertake a more in-depth presentation of the science behind time travel, and because Cox is giving an actual lecture before a live audience, there is no pretense that this program is not meant to be educational. However, the educational orientation of the television special does not

necessitate the rejection of the science-fictional elements. The detailed explanations of scientific ideas are interspersed with the scripted, fantastical scenes from inside the Tardis and, in closing, Cox moves the lecture itself explicitly into the area of speculative science:

Could we design some configuration of matter and energy that would curve the light cones around, so I could get back into my own past? The answer is: We don't know. But nobody has been able to prove that it cannot exist, at least in principle--although most experts believe that it must in some way be forbidden. But there's still the faintest possibility, given the laws of physics as we understand them today, that someone, someday, maybe a young girl, a young boy, will be inspired to try. And even if they fail, by the very act of trying they might just go on to change the world. (Cohen & Harrison-Hansley, 2013)

Cox provides a clear distinction between known science and speculation; he is also explicit about his goal of inspiring children to investigate the wonders of the universe. In Cox's model of the relationship between science fiction and science communication, science fiction can provide the sense of awe and wonder that can inspire young people to reach for the stars.

Conclusion

This paper has employed analysis of three "the real science of" media tie-ins to the *Doctor Who* franchise to suggest that there are several elements that science communicators should consider in developing or evaluating projects such as these, namely the needs: to clearly delineate between fact and fiction; to establish the credibility of science communicators; to create an authentic



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product; and to carefully evaluate methods of science communication prior to undertaking them. The demarcation between science and non-science should be clear. Impossible or wildly improbable science should be labeled as such and then explained with careful attention to the fictional world. Individuals interviewed or quoted in media tie-ins should be clearly identified by name and their credentials as science communicators established. This will allow the audience the chance to evaluate critically the contributions of each participant, and this itself is an important element of science literacy. Media tie-ins—be they books, lectures, or exhibits—must take an authentic, respectful, and thorough approach to the examined work's world of science and its fictional universe. Authors and producers of “real science of” media tie-ins should consider the models of science communication they ultimately employ, so that

decisions regarding how to incorporate science facts into a fictional narrative are made with clarity.

Scholars of science communication should continue to consider fictional entertainment media, particularly science fiction, as one venue for science communication alongside the more commonly-studied science journalism. Just as a newspaper article cannot be evaluated with the same criteria as a textbook, “real science of” media tie-ins constitute a unique form of science communication that must be considered on its own terms. These efforts demonstrate that looking at science through the lens science fiction could provide useful tools for science communicators who aim to promote to science literacy and the popularization of science. The inspirational influence of science fiction is a powerful tool for public science communication.



Riding the wave. *continued*

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- Although it is usually written as TARDIS, the book examined below identifies it as a "Tardis" (without the capitals), so that usage has been adopted throughout the remainder of this paper.