

FUNCTIONING OF INTERSEMIOTIC TRANSLATION OPERATIONS

on the Theoretical Representation of a Black Hole to the Cinematographic Presentation

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Abstract: The following article is part of larger research¹ aimed at demonstrating the function of narrative and visual metaphors regarding the notions of 'space' and 'time' as belonging to the theory of relativity, which are present in a hypercoding or hypocoding operation in contemporary science fiction films. In this case, the analysis focuses on the representation of a black hole in the film *Interstellar* (Nolan 2014). This article is not trying to be a cinematic analysis, but rather an analysis of a process of intersemiotic translation concerning a visual representation in a cinematic textuality.

In the first part of the article, we will show the relation between science and the science fiction genre; this relationship is understood as a form of intersemiotic translation. Thus, the following part of the article will focus on presenting the theoretical framework for understanding this process, which will be exemplified by analyzing the visual representation of a black hole in the film *Interstellar*. From this, we will present the conclusions.

Keywords: Intersemiotic translation, scientific theory, cinema, chronotopic analysis.

Musta augu teoreetilise mudeli intersemiootiline tõlge
kinematograafiliseks representatsiooniks filmis *Tähtedevaheline*

Abstrakt: Järgnev artikkel on osa suuremast uurimusest¹, mille eesmärk on näidata narratiivsete ja visuaalsete metafooride toimimist relatiivsusteooriasse kuuluvate mõistete 'ruum' ja 'aeg' hüper- või hüpokodeerimisel kaasaegsetes ulmefilmides. Antud juhul analüüsitakse musta augu kujutamist filmis *Tähtedevaheline* (Nolan 2014). Selle artikli eesmärgiks ei ole pakkuda filmi põhjalikku analüüsi, vaid keskenduda relatiivsusteooria mõistete intersemiootilise tõlkeprotsessi analüüsile.

Artikli esimeses osas näitame teaduse ja ulmežanri vahelist seost; seda suhet mõistetakse siin intersemiootilise tõlke vormina. Seega keskendub artikli järgmine osa selle protsessi mõistmiseks vajaliku teoreetilise raamistiku esitamisele, mida näitlikustatakse, analüüsides musta augu visuaalset esitust filmis *Tähtedevaheline*. Sellest lähtuvad ka artiklis esitatavad järeldused.

Märksõnad: Intersemiootiline tõlge, teaduslik teooria, kino, kronotoobianalüüs.

¹ Mendoza Pérez, Joaquín, Semiotic Analysis of Intersemiotic Translation Operations Establishing Narrative Metaphors between the Notions of "Time and Space" from the Theory of Relativity to Science Fiction Films, *Interstellar* (Christopher Nolan, 2014) and *Arrival* (Denis Villeneuve, 2016). / UNAM 2022

Introduction

First, we must conduct a review on where the term 'science fiction' originated, as well as the meaning that this term implied. Most of the authors who have studied this genre in specialized journals such as *Science Fiction Studies* converge on the same name: Hugo Gernsback, who, according to Westfahl and Mullen (1994), developed the "idea" of science fiction.

Gernsback wasn't the creator or writer of any prominent sci-fi stories, but he realized that there were a series of written works that shared common elements and could form a genre by themselves. Thus, he created the first science fiction magazine, *Amazing Stories*, founded in 1926. Through its publications, he consolidated the metadiscursive devices and the reference system with which this genre is constantly correlated: science. He argued that science fiction should be "scientifically exact and literally logical" (Mullen Westfahl 1994: 274).

The creative incentive offered by scientific research is very important for creativity. It leads us to interpret its concepts through metaphors and symbols in narrative and visual arts. We can suggest that the theory of relativity and the theory of quantum mechanics have some of the most popular concepts, theories, and ideas that have been explored through science fiction. In this article, we will focus on the theory of relativity. It should be noted that we do not try to prove or deny any aspects of the theory, but rather we argue that the theory had an influence on the narrative system of science fiction stories. Therefore, we will skip the mathematical part and delve mainly into the way in which the concepts of the theory have been interpreted as metaphors or analogies within the cinematographic system.

Therefore, to understand the mechanism behind the functioning of a science fiction film, we need an understanding of the translation model. Through this model, we can observe that the linking mechanisms between a film and a scientific theory, seemingly distant, actually relate in this space where they are in continuous extratextual relationship.

Roman Jakobson, in his article "On Linguistic Aspects of Translation," inspired by the semiotics of Charles Sander Peirce, says that "the meaning of any linguistic sign is its translation into something else, an alternative sign, especially a more developed sign" (Jakobson 1959: 233). For this reason, Jakobson considers translation as a way of interpreting a sign into other signs and proposes three distinct categories: intralinguistic, interlinguistic and intersemiotic translation.

However, while Jakobson goes into depth about the first two, he overlooks intersemiotic translation, the latter being more developed in the works of Umberto Eco and Juri Lotman. Let's review the works of the former. Umberto Eco, in his book *Dire quasi la stessa cosa* makes a series of very interesting proposals regarding the problem of intersemiotic translation. The book consists of several chapters in which we can find very accurate steps towards the construction of a formal method of

analysis. Eco adds a variable to the intersemiotic translation process, the presence of a translator who performs operations to enrich the target text.

Good translators, before they begin translating, spend a lot of time reading and rereading the text, consulting all materials that can help them understand, in the most appropriate way, obscure passages, ambiguous terms, erudite references [...] A good translation always contributes critically to the understanding of the translated work. (Eco 2008: 321)²

Other elements come into play, which are found within the complex system we understand as culture. Lotman says: “For culture to exist as a mechanism organizing the collective personality with a common memory and a collective consciousness, there must be present a pair of semiotic systems with the consequent possibility of text translation” (Lotman 1990: 34). The pair of semiotic systems are the I - S/HE system and the I-I system; the former one is understood as the process of autocommunication, “the bearer of the information remains the same but the message is reformulated and acquires new meaning during the communication process” (ibid.). The process of internal communication within a given culture is what relates and interconnects the texts of that culture, thus narrative texts must have some sort of relationship and have common characteristics that allow us to analyze them.

In this sense, Torop says “It is possible to describe culture as an infinite process of total translation” (Torop 2002: 10)³, a characteristic of cultural autocommunication. And to understand and analyze this relation of translation within a story he proposes the chronotope, a unit of analysis that can show “the interrelationships between plot and story, and the beginning and end. In the end, any story is about human events and movements (or states) in space and time” (ibid., 21)⁴.

For this reason, according to Robert Stam (2014), “a chronotopic model can facilitate the construction of a more inclusive model for the analysis of time-space in cinema, by simultaneously considering questions about history, genre, and the specifically cinematographic articulation between space and time.” There are three types or levels of chronotopes according to Torop: the topological chronotope or the “the succession of events and the real world, more or less recognizable to the viewer”⁵ (Torop 2002: 21) with which the reader comes into contact; the psychological chronotope “which conveys the character’s aspect to the viewer, self-assessment and assessment of other people or events”⁶ (ibid.); and the metaphysical

² Author’s note: This is a translation made by the author, the original version of this quote is from a Spanish edition of the text, where it is necessary I will add the original quotation: “Los buenos traductores, antes de empezar a traducir, pasan mucho tiempo leyendo y releendo el texto, y consultando todos los materiales que les puedan permitir entender de la manera más apropiada pasos oscuros, términos ambiguos, referencias eruditas [...] En este sentido, una buena traducción resulta siempre un aporte crítico a la comprensión de la obra traducida”.

³ “Es posible describir a la cultura como un proceso infinito de traducción total”.

⁴ “las interrelaciones entre prosa y filme, que estos problemas son resueltos primeramente en el marco del cronotopo (tiempo-espacio).”.

⁵ “la sucesión de acontecimientos y el mundo real, más o menos reconocible para el espectador”.

⁶ “(un actor) es el centro del cronotopo psicológico que transmite el aspecto del personaje al espectador, autoevaluación y evaluación de otras personas o sucesos”.

chronotope whereby “The authors create a film based on certain purposes or conceptions; their primary objective is to create a cohesive whole and to communicate a clear and general conception to the audience”⁷ (ibid.).

Therefore, the chronotope as a unit of analysis will allow us to observe within a specific representation in cinematic textuality the influence of significant entities derived from the theory of relativity. These significant entities will, in turn, be categorized in the analysis based on Peirce’s ten classes of signs, as a way of understanding the taxonomy and composition of chronotopes.

This work proposes to expand the boundaries of semiotic studies in cinema by integrating them into the paradigm of intersemiotic translation. It acknowledges that cinema operates as a signification system that is in constant interaction with other textualities, facilitating its interpretation, as well as its processes of design and creation.

It is of utmost methodological importance to consider the film as a text. In this analysis, based on Hjemslev’s model and following Eco’s proposal, we structure both textualities, scientific and cinematic, into a plane of expression and a plane of content, as a methodological approach to understanding which textualities and systems of signification are related through chronotopes. From the separation of the translation process into the two planes that compose a text, we have as a consequence two different operations: “adequacy of form of content” and “equivalence of form of expression”. The first refers to the following: “Given the complete spectrum of content [...] the translator must choose the most probable, reasonable, and relevant meaning or sense in that context and in that possible world” (Eco 2008: 57)⁸, that is, the “meaning” that the representation adopts in the target system based on its relationship with the source system. “The content must adapt, so to speak, to that expressive obstacle”⁹ (ibid., 71).

For the “equivalence of form of expression,” the expression of two different systems of signification is confronted. Therefore, the translating agent “[...] has negotiated by choosing to pay attention to certain levels of the text” (ibid., 321)¹⁰, in order to represent in a different code what belongs to the source system in an equality of communicative values. “Meaning occurs when an expression is replaced by another from which all the inferential consequences of the first follow” (ibid., 296)¹¹.

⁷ “Los autores producen un filme a partir de ciertos propósitos o concepciones; su propósito principal es crear un todo, comunicar una concepción al espectador de manera clara y general.”

⁸ “dado el espectro completo del contenido [...] el traductor debe elegir la acepción o el sentido más probable, razonable y relevante en ese contexto y en ese mundo posible”.

⁹ El contenido debe adaptarse, por así decir, a ese obstáculo expresivo”.

¹⁰ “[...] a negociado eligiendo prestar atención a determinados niveles del texto”.

¹¹ “El significado se da cuando una expresión es sustituida por otra de la que se siguen todas las consecuencias ilativas que siguen de la primera”.

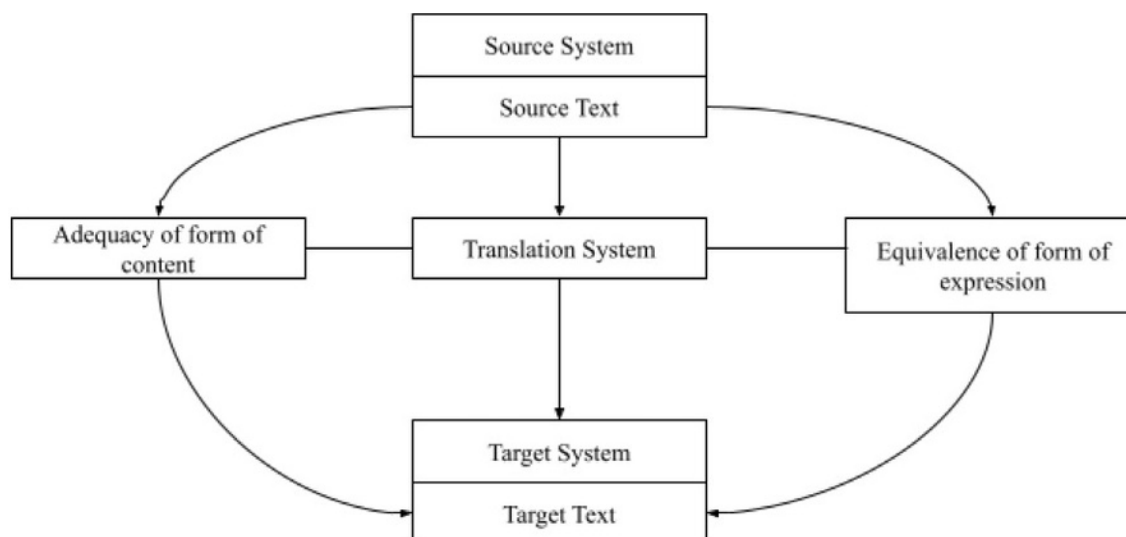


Figure 1. The process of intersemiotic translation. The figure depicts the process of intersemiotic translation through the operations of equivalence of expression, Form, and adequacy of form of content, which occur through a translation system.

But, in between the translation process from scientific theory to a cinematic representation, another very interesting phenomena occurs. There is a problem of representation for the entities for which there is no empirical knowledge, thus the representation has to be achieved through speculations and manipulations of visual codes.

If the code is formed by rules that produce specific and stable specimens, the first form of extension will be adding an additional rule based on these existing previous rules. Eco calls this 'hypercoding'. Furthermore, "hypercoding regulates the meaning of more macroscopic strands: rhetorical and iconological rules are of this type. Given certain coded units, they are analyzed into smaller units to which new semiotic functions are assigned" (Eco 2005: 213)¹². These will gradually be accepted within a culture through a process of adaptation.

Likewise, Eco proposes another way of producing new meanings, called 'hypocoding', which

can be defined as the operation by which, in the absence of more precise rules, macroscopic portions of certain texts are provisionally admitted as pertinent units of a code in formation, capable of transmitting vague but effective portions of content, although the combinatorial rules that allow the analytical articulation of these expressive portions remain unknown (Eco 2005. 216)¹³.

¹² "la hipercodificación regula el sentido de ristas más macroscópicas: las reglas retóricas e iconológicas son de este tipo. Por otro, dadas determinadas unidades codificadas, se les analiza en unidades menores a las que se asignan nuevas funciones semióticas".

¹³ "puede definirse como la operación por la que, a falta de reglas más precisas, se admiten provisionalmente porciones macroscópicas de ciertos textos como unidades pertinente de un código en formación, capaces de transmitir porciones vagas, pero efectivas, de contenido, aunque las reglas combinatorias que permiten la articulación analítica de dichas porciones expresivas sigan siendo desconocidas"

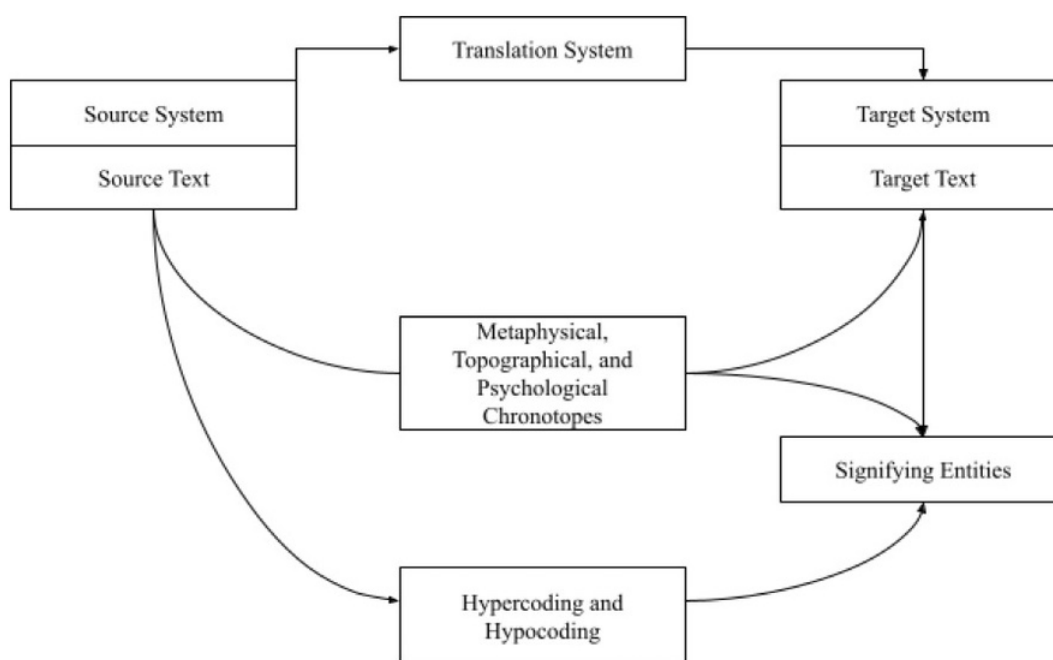


Figure 2. Operations in the process of intersemiotic translation. The figure shows the operations involved in the process of intersemiotic translation. Firstly, it demonstrates how chronotopes serve as the unity of analysis that allows us to observe the process, and the operations of hyper- and hypercodification as part of the translation process that creates signifying entities in the target system.

Thus, the analysis continues as follows: the chronotopes as the unit of analysis allows us to segment specific entities of the film, which are classified under Charles Sanders Peirce's ten classes of signs. Within these specific signifying entities, we observe the process of translation through the operations of adequacy of form of content and the equivalence of the form of expression, in which we observe an operation of hyper and hypocoding.

In this way, the intention is to demonstrate, through the analysis, production and design considerations for the creation of science fiction audiovisual projects. By understanding the mechanisms of signification involved in this cinematic genre, we can enhance the competency of both the audiovisual text and the viewer by making adjustments that allow them to be integrated into the usual consumption paradigms. Similarly, understanding these mechanisms allows an increased relationship between both texts within the culture, enabling us to observe the progress of a genre that is in constant evolution.

Analysis of the representation of a black hole: *Interstellar*

Interstellar (Nolan 2014) is a movie released in 2014, directed and co-written by Christopher Nolan (*Inception*, *The Dark Knight*), and starring Matthew McConaughey,

Anne Hathaway, Jessica Chastain, Bill Irwin, Matt Damon, and Michael Caine. The plot follows Cooper (McConaughey), who must leave his family and the Earth's decay behind to lead a group of astronauts on an interstellar journey to find a new home for humanity. In the third act of the film the heroes must face the problem of space dilation when they come close to a black hole.

A black hole is a region of spacetime with the property that the gravitational field is so strong that nothing entering that region can ever escape from it [...], the boundary of which is called the event horizon [...]. Once the event horizon is crossed, by definition, one cannot return; moreover, an observer who remains outside can never see anything that happens inside it. (Wald 1998: 113).

We consider the theoretical model¹⁴ of the black hole as an object of analysis since its existence arises as a possibility from the theory of relativity, both in the theoretical plane and later in the derivations in fictional narratives.

In the field of physics, the proof of existence for this object came as a consequence of Karl Schwarzschild's solution to Einstein's field equations of gravitation. What the solution, and in general the equations, show is a generalization of the theory of relativity to include the effects of gravitation on space and time, which subsequently represented the possibility of time dilation.

In the film, our protagonists explore the exterior and interior of the black hole. We will focus in this analysis on the exterior visual representation of the black hole. The audience has a first encounter with this object when our characters traverse the wormhole and find themselves in another galaxy where planets orbit around a black hole. It is consistent with the topographic chronotope of the film as it is an existing element within the reality of the characters and the narrative. At the time of the film's production, there was no empirical evidence regarding the visual characteristics of this object. Thanks to the recognition being based on the validity of the audiovisual discourse, the director and his production team made an inferential proposal of the visual form of this phenomenon.

Firstly, according to the description provided by Kip Thorne (2014), Einstein's equations were used to program its structure, which we received as visual representation. Its plastic characteristics such as color and shape emerged from theoretically plausible considerations of this phenomenon. The very nature of the object was considered; for example, a black hole by definition emits no light, and if the cinematic code is built from a device that perceives light to construct images, this posed a challenge. However, up to this point, we can see how there are forms in the planes of expression and content belonging to the source system that were put into operation through the narrative to construct the cinematic representation. Additionally, it is important to highlight how the equations were used to manipulate

¹⁴ We understand the concept of a theoretical model based on Max Black's proposal, in which *"the mere description of an imaginary but possible structure was sufficient to facilitate scientific investigation"* (Black 1967: 34)
"la mera descripción de una estructura imaginaria, pero posible, bastaba para facilitar la investigación científica" (Black 1967: 34)

digital codes for audiovisual representation; this can be considered as an equivalence of form of expression operation.

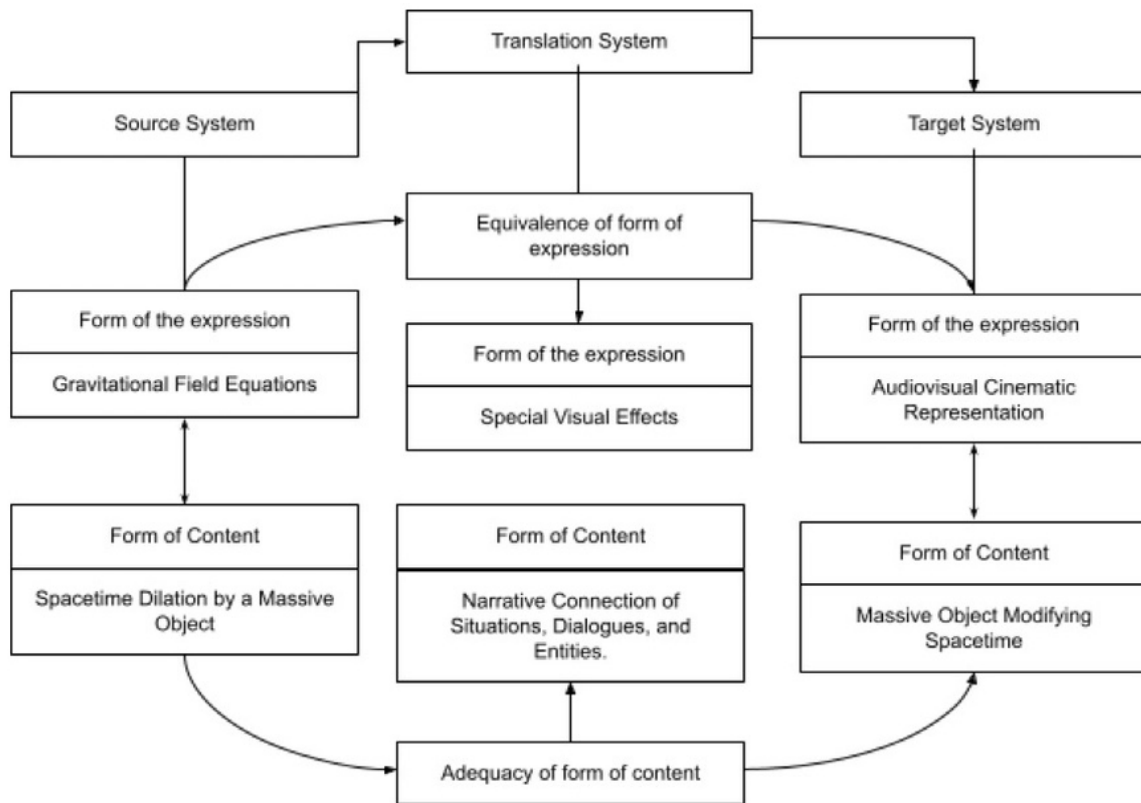


Figure 3. Intersemiotic translation of a black hole. The scheme shows the process of intersemiotic translation for the cinematographic representation of a black hole, showing each of the entities that take part in the process.

In that sense, what we perceive is a signifying construction based on the hypocoding of how the camera would perceive the object: rays of light affected by a black hole. This was produced by Kip Thorne, Christopher Nolan, and the visual effects team at Double Negative, led by Oliver James, as Thorne describes it:

Using Einstein’s relativistic laws of physics and leaning heavily on prior work by others (especially Brandon Carter at the Laboratoire Univers et Théories in France and Janna Levin at Columbia University), I worked out the equations Oliver needed. These equations compute the trajectories of light rays that begin at some light source, for example, a distant star, and travel inward through Gargantua’s warped space and time to the camera. From those light rays, my equations then compute the images the camera sees, taking account not only of the light’s sources and Gargantua’s warping of space and time, but also the camera’s motion around Gargantua. (Thorne 2014: 97)

And if this process wasn’t complicated enough, the size and shape of a light ray passing through the black hole were also taken into consideration. Finally, to this code, created to produce an accurate and as realistic as possible image of a black

hole, an accretion disk was added, the part of the structure of the black hole where “the gas settles into a hot, bright, rapidly spinning disk”¹⁵.

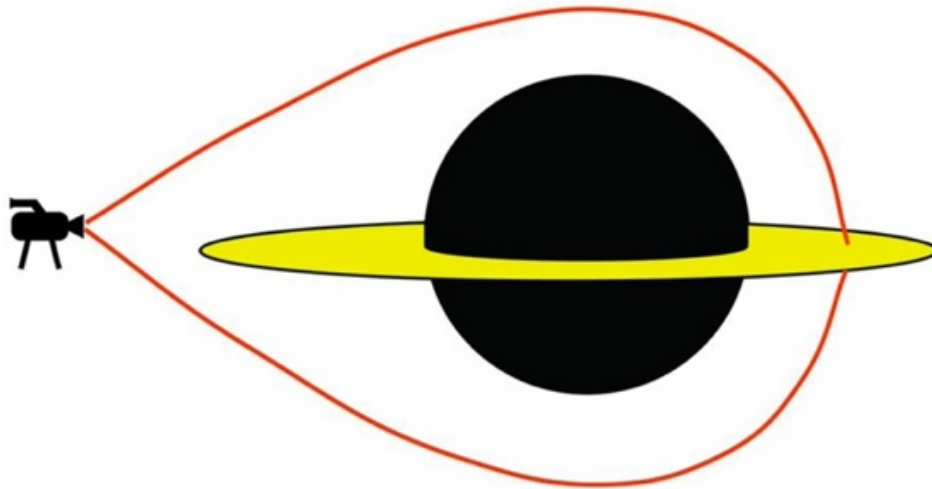


Figure 4. Hypothetical representation of how a camera could capture the light emitted by a black hole (Thorne 2014).

Thanks to this information, we can clearly distinguish the metaphysical chronotope as well as its influence on the topographical choronope. The metaphysical, as Torop indicates, is “the conception of the text through the interrelations between the different chronotopical levels” (Torop 2019: 30), which shows us the intention of creating a hypothetical representation that was scientifically plausible, based on the state of knowledge that the creators of the movie had. From this, the visuality of the black hole is constructed and designed, also showing a deep impact on the conceptualized reality of the movie, ensuring scientific accuracy in the film’s portrayal of phenomena like black holes. As Kip Thorne indicated during pre-production: “Nothing in the film will violate firmly established laws of physics, or our firmly established knowledge of the universe. Speculations (often wild) about ill-understood physical laws and the universe will spring from real science, from ideas that at least some ‘respectable’ scientists regard as possible” (Thorne 2014: 12).

The representation consists of a series of levels; visually, it operates as a diagram, as its construction is a hypothesis about the object’s visuality. However, to analyze it, we must consider the origin of these speculations and their signifying function according to Peircean categories. We identify the black hole within the source system, that is, the gravitational field equations, as a rhematic iconic legisign, as these mathematical formulas within Peircean semiotics, according to Mauricio Beuchot, are considered iconic forms.

¹⁵ Accretion Disk (s.a): In NASA Anatomy of a Black Hole. Retrieved from <https://science.nasa.gov/universe/black-holes/anatomy/#accretion-disk>, 28.03.2024

It is also seen in algebraic formulas; each one of them [...] is an icon to the extent that it exhibits through the algebraic signs (which in themselves are not icons) the relationships of the quantities in question' (Peirce and Vericat, 1988: 148). That is, they are not simple signs, but compounds. They have a natural part and a conventional one, but based on similarity (Beuchot 2019: 23)¹⁶

In this manner, what concerns us for the analysis is the representation of two important elements in the represented object: the description of the trajectory of light and the description of the change in size and shape of a light ray that passes through a black hole.

Translation occurs through the narrative but also through another system of signification, special effects. In this process, the very material upon which the images of the audiovisual system are created is altered and modified. Additionally, at this stage of development, other structural elements of a black hole, such as the accretion disk or the stars and galaxies surrounding the black hole are added.

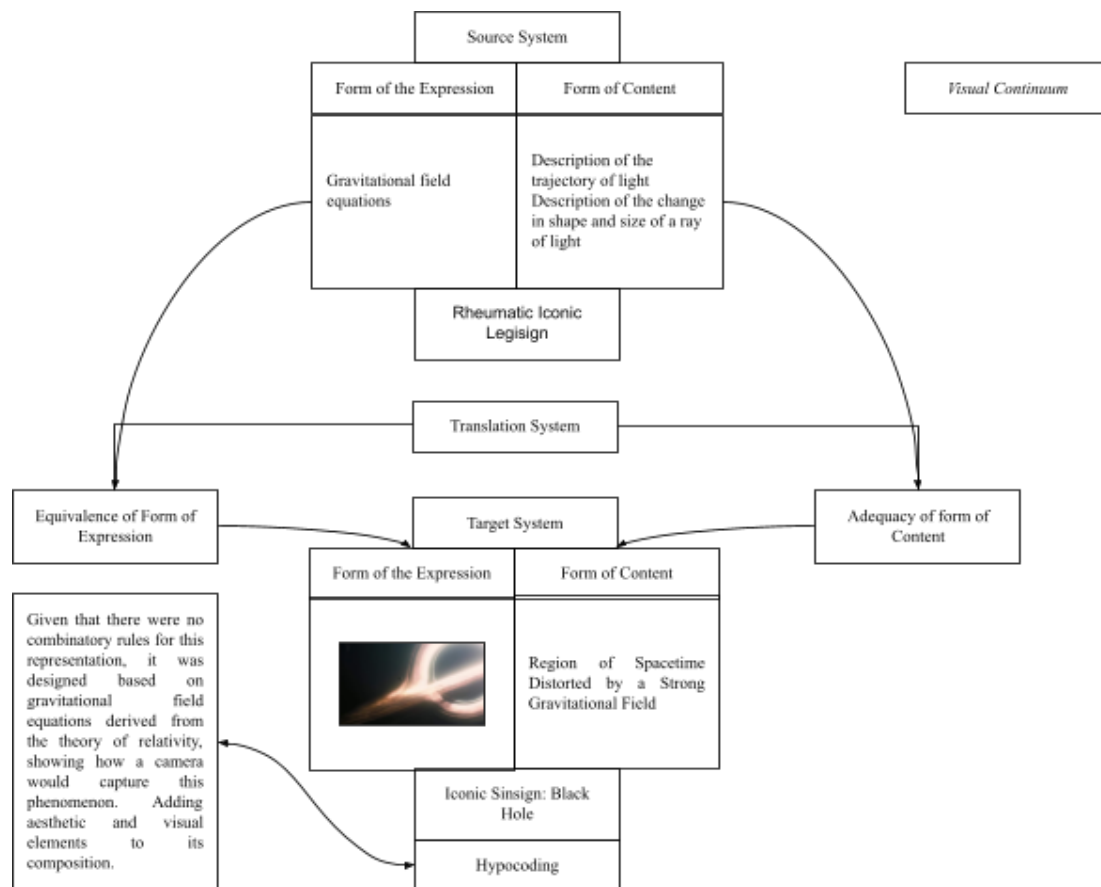


Figure 5. Intersemiotic translation operation for the visual representation of a black hole. The diagram illustrates the process of intersemiotic translation, demonstrating the transfer of signifying entities from the source system to the target system through hypocoding.

¹⁶ "También se ve en las fórmulas algebraicas; cada una de ellas [...] es un ícono en la medida en que exhibe mediante los signos algebraicos (que en sí mismos no son íconos) las relaciones de las cantidades en cuestión" (Peirce y Vericat, 1988: 148) Es decir, no son signos simples, sino compuestos. Tienen una parte natural y otra de convención, pero basadas en la semejanza".

Conclusions

It is important to consider the influence and consequences of communication between these two systems. From the transition of the system of signification from science to the audiovisual system, we see a relationship of inductive/abductive inference. What this means is that science fiction draws inspiration from science to speculate about scenarios, events, or situations for its stories. It takes representations from science such as diagrams, metaphors, explanations, and even equations to construct audiovisual representations, in this case of the black hole.

It operates based on what Umberto Eco calls a cognitive type: "The scheme that allows us to mediate between the concept and the multiplicity of intuition" (Eco 1997:115)¹⁷. The cultural models that are constituted from these relationships are what allow various non-empirical objects derived from thought experiments to become "thinkable" and be translated into audiovisual products.

From the transition of the audiovisual signification system to the text and from the text to the audiovisual signification system, two processes of deductive nature occur. First, from the audiovisual signification system, the rules that will be applied to the story and representation are specified. From the text, the rules and codes created will once again become part of the audiovisual signification system and have already been encoded.

These textual entities, potentially, can be put into dialogue again with the signification system of science. Just as it has happened before, remembering that many terms, notions, and concepts originated from ideas in science fiction.

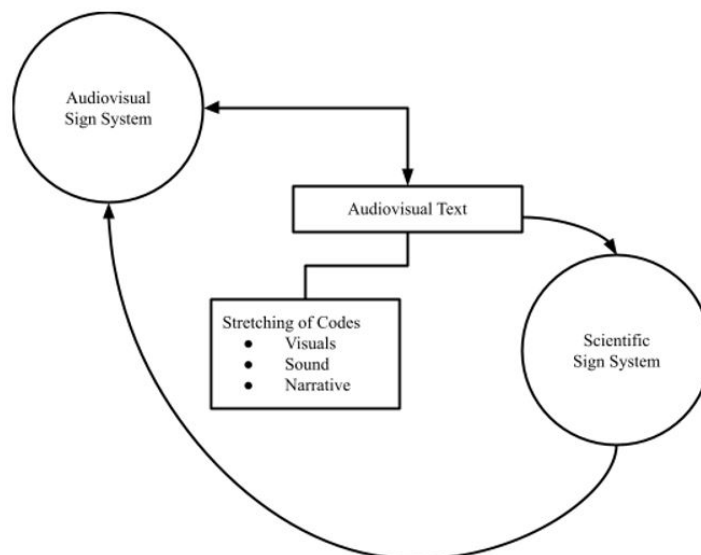


Figure 6. System communication. The diagram shows the communication process between the audiovisual signification system and the scientific signification system, through an audiovisual text, in this case a film.

¹⁷ "El esquema que nos permite mediar entre el concepto y lo múltiple de la intuición".

In the case of *Interstellar*, this process of communication between systems is very interesting. As we saw earlier, to design the visual structure of the black hole, equations of the trajectory of light when encountering a black hole were encoded (through digital codes that create the visual representation). In 2019, NASA published, for the first time, an image of a black hole:

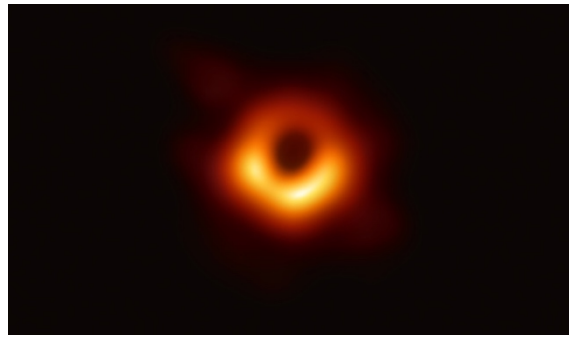


Figure 7. NASA's first image of a black hole. Scientists used the Event Horizon Telescope to capture an image of the black hole located at the centre of the galaxy M87.

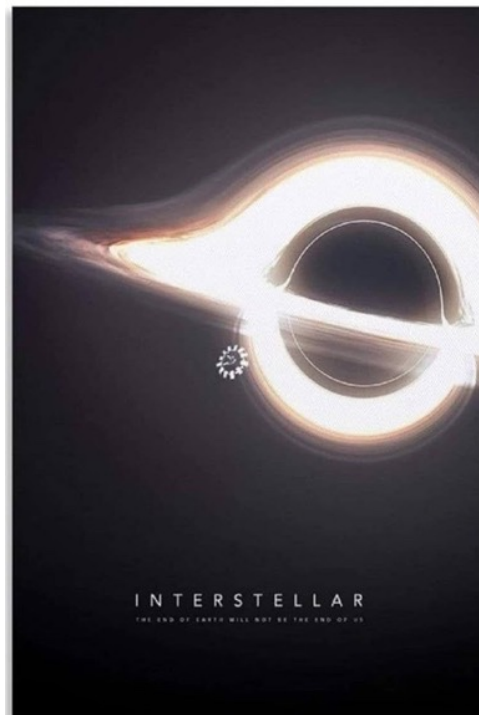


Figure 8. *Interstellar* representation of a black hole. Movie poster depicting the representation of a black hole as portrayed in the film.

This image bears a very close visual similarity to the representation created for the film *Interstellar*, which demonstrates, firstly, a correct hypocoding by the film's producers. Understanding that the proximity of a cinematic representation to a theoretical model does not make it more incomprehensible; on the contrary, when the necessary frameworks are established to stimulate the imagination, a faithful and interpretable representation is achieved, or a cognitive type that adequately mediates the representation of an empirically unknown object.

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