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Phantasms of the Sun and Venus: Tacit Cinematic Knowledge in Astronomy

Rakin, Jelena

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TACIT

CINEMATIC

DGE

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OF FILM**

REBECCA BOGUSKA

GUILHERME MACHADO

REBECCA PUCHTA

MARIN RELJIĆ

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Tacit Cinematic Knowledge

Tacit Cinematic Knowledge: Approaches and Practices

**edited by Rebecca Boguska, Guilherme Machado,
Rebecca Puchta, and Marin Reljić**



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Phantasms of the Sun and Venus: Tacit Cinematic Knowledge in Astronomy

Jelena Rakin

This article examines aesthetics as a form of cinematic episteme in moving images produced from contemporary astronomical observations. This analysis is followed by a closer examination of significant historical image *dispositifs*, such as drawing, photography, and film in respect to how they create visual renditions of time-based astronomical phenomena. Consequently, the article draws connections between media ontologies and aesthetics in an interdisciplinary context, from cinema to contemporary astrophysics. This examination demonstrates the role of aestheticizing principles in natural sciences by focusing on the techniques of time-lapse, editing, and superimposition.

Mesmerizing Color Spheres: Solar Images from the US National Aeronautics and Space Administration (NASA)

On June 5 and 6, 2012 Venus transited across the Sun. The event was captured by NASA's Solar Dynamics Observatory satellite (SDO), launched in 2010 to gather information about the Sun. The transit of Venus is a rare astronomical event and its last occurrence in 1874 led to the development of a novel, proto-cinematographic device—the photographic revolver that the French astronomer Jules Janssen constructed to capture the planet's transit, frame by frame.

As part of NASA's outreach to the general public, the SDO's recordings of the 2012 transit are available for viewing on the observatory's website. The visitors can watch "Venus Transit Movies" under the category "Outreach" in mp4 format (NASA 2021a). The multiple available transit movies differ as to what portion of the Sun is visible in the frame, as well as in the data they use. They show either a detail of ingress (the planet's initial "entrance" over the sun), a detail of egress (the end of the transit), or a view of the entire sun. The data comes from two of the SDO's three instruments: the Helioseismic and Magnetic Imager (HMI) and the Atmospheric Imaging Assembly (AIA).¹ Data from the AIA includes images of the Sun in ten wavelengths every ten seconds, whereas some of the Venus transit movies are also composites of several AIA wavelength recordings and of HMI data (NASA 2021b). The website's video player specifies that the movies are being played at 16 frames per second.

The choice of the word "movies" and the reference to the standard projection measurement of 16 frames per second suggests a paratextual reference to the cinematographic *dispositif* as a general strategy of outreach from the scientific astronomy

1 SDO also carries the Extreme Ultraviolet Variability Experiment (EVE).

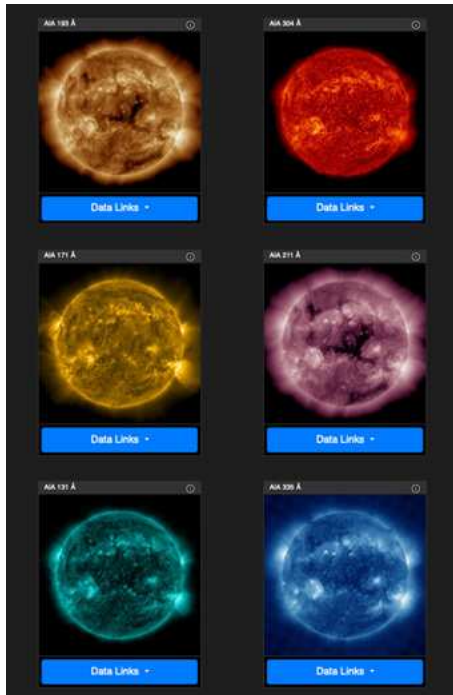
community to the public. One finds similar references on the website of the Solar and Heliospheric Observatory (SOHO), where under the site heading “SOHO Movie Theater,” the viewers can generate videos of Venus’ transit and many other movies of the Sun by entering two dates (NASA 2021c). In an additional paratextual reference to cinema, the design of the SOHO website’s gallery shows the image icons of the movies framed by digital imitations of the perforations on an analog film strip. This is an obvious reference to a media imaginary since the technology at work in both the SDO and the SOHO is digital. But it is, however, not too far-fetched to allude to such technological “antecedents”² in this case, since many of the epistemic questions that these moving images raise pertained to earlier, analog models of image generation as well. Therefore, in this essay, I go beyond mere paratextual references to the cinematic *dispositif* to examine the ontological and epistemological connections between cinema and the production of moving images in astronomy. Specifically, I analyze the visual renditions of time-based, processual, astronomical phenomena as a form of film-photographic knowledge. Significant for my study are the heterogenous manifestations of temporal synthesis in film and photography, and the aesthetic role ascribed to the perceiving subject. What I call the heterogeneity in the visual rendering of temporal phenomena in astronomy encompasses such aspects as the choice of varied time intervals and the different manifestations of time as a phenomenon on the surface of the image.

The SDO website offers several different forms of time-lapse movies. The viewers learn that the observatory captures an image of the Sun every second, a frequency that supersedes the two other spacecraft also recording the images of the *Sun*: *Solar and Heliospheric Observatory* (SOHO) and *Solar TERrestrial RElations Observatory* (STEREO): “SDO takes 1 image every second.

2 Antecedents here does not refer to a strict technological genealogy but to a shared image practice in a functional sense.

186 At best STEREO takes 1 image every 3 minutes and SOHO takes 1 image every 12 minutes” (NASA 2021b). Given the extent of the data collected in one-second intervals, it is interesting that the SDO website provides—perhaps even showcases—various formats of time lapse movies. These movies opt for sequences with much longer time intervals than the available data allows for. Significantly, the longer intervals are of central importance to the visual rendering of motion. In a sense, they create motion that would otherwise not be perceivable as such—just as looking directly at the Sun would not reveal most of the information collected by the observatory. Thus, the time-lapse effect becomes a form of producing visibility. Furthermore, “The Sun Now” webpage offers “48hr videos” that play in twenty-second time-lapse loops (NASA 2021e). The “Browse Data” category allows visitors to generate a movie from historical data. They can choose two dates in the calendar as well as different AIA or HMI data channels (or their composites) as the basis for the movies. Visitors can also choose their own image cadence: for instance, choosing a “5,” means that “the application will return one in every fifth image to the user” out of a total limit of 500 per query (NASA 2021d). The generated movies show the sun positioned centrally in the image, rotating as the video loops. Different colors are used for different wavelengths: gold, bronze, red, teal, blue, green, yellow/green, pink, gray etc. (see fig. 1). Numerous variations of the same sphere that represent the Sun exemplify both a literal as well as a metaphorical plurality of views. The movies are aesthetically mesmerizing, hypnotic loops of rotating, colored spheres.

These fascinating spheres in “false colors” (chromatic renderings commonly used to visualize the information on the non-visible parts of the electromagnetic spectrum) point to epistemic models other than the scientific ones—particularly, models that could be identified as cinematic. On a most basic level, these movies are examples of a conventionalized visualization, i.e. the representation of a process enabled by moving images.



[Figure 1] Detail of the Solar Dynamics Observatory website with various videos of the Sun (Source: NASA 2021e, courtesy of NASA/SDO and the AIA, EVE, and HMI science teams.)

Underlying the evidentiary status of a physical reality translated in familiar codes, however, are mechanisms of aesthetic crafting that capitalize on the malleability of the moving cinematic image and its ability to produce a distinctly wondrous reality.³ This crafted sense of wonder is significant, since as I will show later, the word “magic” is often used in relation to today’s science, notably in regard to its speculative nature and the covert or overt

3 Lynda Nead identifies aesthetics of wonder as one of the key qualities of the astronomical images (2007, 201–206).

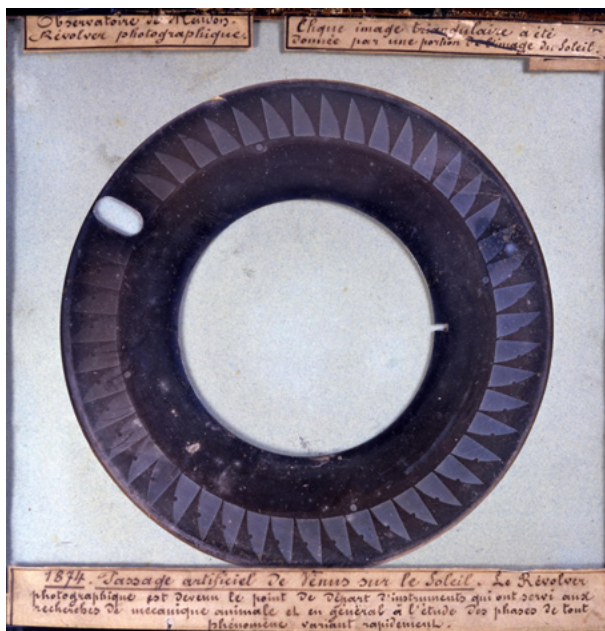
188 role of aesthetic choices informing theories and the presentation of experimental results.

Several approaches to visual representations of the passage of time which were developed in the 19th century and are still used today—including the techniques of long-exposure photography, instantaneous photography, and moving images—exemplify the specific relationship between aesthetics and epistemes, or rather they exemplify *aesthetics as an episteme*. They underline the contingencies involved in rendering the passage of time as an image surface phenomenon and bring to fore the significant role that aesthetic and subjective choices play in shaping such renderings. Therefore, the next section of this essay looks at historical ways aesthetic concerns have shaped the production of astronomical images and their unique relation to the perceiving human subject.

Aesthetic Time in Drawing, Photography, and Cinema

Images of the cosmos are a particularly instructive corpus for examining the temporal dimensions of film and photography, since celestial phenomena generally exceed human sensory capacities (in terms of their limited vision, human life span, etc.). Throughout the history of astronomy, the human body and its limited scale posed specific challenges for the observation of astronomical phenomena, such as the strain of observing over long time periods and the necessity for optical devices like a telescope to aid the naked eye.⁴ Thus, the phenomenological unavailability of the cosmos underlines the constructed nature, mediality, and the influence of cultural imaginaries (both

4 With regard to the strain of a long observation of the night sky, Dava Sobel (2016) studied how the Harvard Observatory employed women because they were practical, cheap labor, and, at the same time, executed the strenuous work with the necessary precision.



[Figure 2] Disk-plate recording of the 1874 Venus transit (Source: Library of the Paris Observatory 2021).

aesthetic and scientific) that characterize those images that represent it.

The non-immediacy of the experience of the cosmos was greatly influenced in the 19th century through the introduction of an intermediary, the photographic apparatus, that propelled astronomy to become a highly visual science at the end of that same century. Jimena Canales identifies the introduction of photography into astronomy as a “cinematographic turn,” pointing out the fact that the cinematographic apparatus itself emerged from the field of astronomy—namely, from Janssen’s photographic revolver, which he had constructed in 1874 to photograph the Venus’ transit across the sun at intervals of about one second (see fig. 2). The apparatus that Janssen developed

190 was further modified and adapted in Etienne Jules Marey's physiological laboratory and then in the studio of the Lumière brothers, where it served as a basis for the development of the cinematographic camera (Canales 2002, 588). The recordings of Venus' transit were captured on a disk that resembles 19th-century optical devices such as the *phenakistiscope*, which came into use around the 1830s and which provided an illusion of motion through the rotation of the disk, producing a looping repetition of the motif.

The discourses surrounding the introduction of photography in place of astronomical drawings show the degree to which the generation of images involved intervention of an aesthetic nature, not solely in the service of verisimilitude. Whereas photography was associated with "verisimilitude" and empirical exactness, it was not necessarily associated with "truth" (Canales 2006, 281), and in the second half of the 19th century many discourses questioned the supremacy of the mechanical reproduction of the stars offered by photography (Soojung-Kim Pang 2016). Drawings, especially, were preferred over the photography for their predisposition to separate the "important" from the "irrelevant." In his manual on astronomical drawing from 1882, the French Astronomer Étienne Léopold Trouvelot pointed out the supremacy of a well-trained eye over a photographic camera (1882, Vlf.). The remarks he made about his drawing of "November Meteorites" are informative about the importance of making subjective choices in the visual synthesis of time. Trouvelot recorded an impression from 3000 observed meteorites, where an ideal view implies that "the shooting stars delineated, were not observed at the same moment of time, but during the same night" (1882, VI–VII). The period of transition from astronomical drawing to astrophotography in the late 19th century thus brings to the fore a fluctuation in the location of meaning and perceived truth, vacillating somewhere between the perceptual and cognitive faculties of the subject and the physical world, and, as a

consequence, demonstrating the interrelation of aesthetics and science in representations of the cosmos.

A very cautious attitude towards the assumption that a film-photographic image provides unambiguous evidence also informs some classical texts on film and photography of the early 20th century. For example, both, Walter Benjamin and Jean Epstein, point out film and photography's ability to record phenomena beyond what is perceptible with the mere human eye: Benjamin does this with his notion of the "*optical unconscious*" and Jean Epstein by musing about the ramifications of the invisible spectrum of ultra-violet light in the cinematographic image (Benjamin 1979, 202; Epstein 2008, 33). Both thus suggest that the evidentiary status of film-photographic images extends the limited scope of anthropocentric vision.

For Benjamin, there is also a significant difference between long exposure and instantaneous photography. He compares the result of long exposure to that of a painted portrait, where, owing to the time passing during the photo-chemical inscription, the history of the photographed person is inscribed into the image. However, according to Benjamin, this does not apply to instantaneous photography (Benjamin 1979, 204). The idea of a single truth that cannot be captured in photography also informs Siegfried Kracauer's (1997) thinking. Similarly to Benjamin, he compares portraiture in painting and photography, concluding that photography captures the coherence of the surface but not the meaning.

These different observations point to the belief that the semantic (or epistemic) locus of temporal synthesis and the selection of information is the human subject executing the painting or a drawing. In contrast to a mechanical apparatus, a painter filters visual information, separating the relevant from the irrelevant. The time and subject represented in painting and drawing are thus, principally, an inner image of the human subject.

192 In photography this synthesis is done by the apparatus: stars draw themselves, as the vocabulary of the 19th-century discourses implies. However, as Benjamin was right to point out, time does not simply equal time in photography. Photography opens a range of techniques for translating time onto a two-dimensional surface. When contrasted, interval photography, long exposure, and instantaneous photography of celestial skies show different manifestations of time as an image surface phenomenon, with varying graphic qualities. It becomes evident that the reference to time here relates not only to the astral phenomenon under observation, but also—and importantly—to the apparatus itself as the producer of the visibility of time.

As opposed to the synthesis of time on a still, two-dimensional surface in drawing and photography, moving images also make time perceptible through motion. Cinematographic time-effect techniques such as slow motion and time lapse draw attention to the character of time as well as the process of its construction and visualization. Still the lifelikeness of cinematic representation has repeatedly been disputed, starting with turn-of-the-19th-century discourses on the synthesis and analysis of movement. Informative in this case are two opposing philosophies predominant in 19th-century France: one ascribed to the notion that “synthesis is composed through the summation of discrete moments of analysis” and the other being an “alternative philosophy of form and movement where ‘sentiment’ and ‘spirit’ played essential roles” (Canales 2006, 289). The proponents of the latter argued that “movement was not composed of discrete moment summations” (Canales 2006, 278), but was instead “life, volition and, therefore, divinity. Representations of movement were ultimately representations of ‘grace’—the quality which brought all of these elements together” (Canales 2006, 279). By stressing the sentiment and the spirit, they warned that meaning and knowledge cannot be grasped by mathematical principles or by logic alone—even if, by contrast, in the same century, the promise of “photographically mathematized nature” propelled

Vital Movement in Cinema and Magic Bodies

The notion of “vital” movement in cinema is also taken up in contemporary film scholarship (Albera 2002). François Albera contrasts the notion of “vital” movement with (merely) sequential movement in cinema editing. Importantly, he also recognizes the act of editing in the photographic long-exposure process and makes a point to distinguish it from the kind of editing that produces the sequential nature of cinematic photograms. Instead, for Albera, editing also encompasses superimpositions on the same photogram, and, moreover, is not merely a technical operation.

There is an unlikely comparison that can be drawn between the video loops of the Sun on the SDO website described earlier and the observations Albera makes in relation to the *zoetrope* and *phenakistiscope* (see fig. 3). In the circular movements of these 19th-century optical devices, Albera identifies non-narrative, vital movement as well as epistemic questions raised by the process of editing to create this repetitive motion:

The alternation of the phases in a zoetrope or some other optical toy does not have as its goal so much to narrate, to unfold a temporal sequence (he jumps, he runs) as to incite the dynamics of a jump or a run. There is a notion of a ‘vital’ movement: one that differs from succession. ... On certain phenakistiscope disks one can observe a multiplicity of movements generated by a rotational motion ... it is a

5 The notion of film being a universal language ensued a couple of decades later, in the early 20th century, but it took the physiognomy of a gesture (cf. Balázs 2001) as its point of departure, which, in turn, is related to the vitality-of-the-movement line of thinking.



[Figure 3] Phenakistiscope disk showing a shooting star, 1833 (Source: Australian Centre for the Moving Image 2021, photographed by Egmont Contreras, ACMI).

movement 'in place,' every different shape being super-imposed over the preceding one. (Albera 2002, 16)⁶

And, furthermore: "[t]he recognition of the process of montage in the mere passage from one state to another, as minimal as it can be, represents at the same time an artistic as well as an epistemological question" (Albera 2002, 21).

It is precisely the vitality of movement-as-passage that the SDO's Sun recordings offer their viewers. Even though the movies make an ostentatious case for the existence of a linear interval through the use of time-lapse composition, the sense of vital passage is prominent in the contrast between the circular movement of the Sun disk and its static framing in the center of the image. Not only are the viewers presented with the rotational movement "in the same place" ("mouvement 'sur place' ") (Albera 2002, 16), but in the movies that layer several data channels within a single image, the viewers are also presented with *editing through*

6 All translations by author.

superimposition. The Sun becomes a malleable body, first dis-aggregated into different wavelengths and then re-constituted through superimpositions and the time-lapse effect. The loop option also undermines the notion of linear succession. Instead, what is captivating is the flux of perpetual transformations, comparable to observing a water surface ruffled by the wind. The exact meaning of the consistent motion seems to be less certain. What is established as the dominant perceptual principle, however, is the anticipation of enchainned transformations.

In the case of Georges Méliès' films, Albera identifies a similar focus on composable and decomposable bodies instead of linear action: "[i]n the case of Méliès, the editing does not strive for the linearization of the filmic signifier; instead, it plays with the reference to the mechanical body, disassemblable, super-imposable. ... Méliès brings us unequivocally into the area of the aforementioned superimposition" (Albera 2002, 27). The tendency of disaggregating and compositing physical bodies bears witness to the desire to link mechanics with magic, an impulse Albera recognizes in the Méliès's films when he points out that editing belongs to the genealogy of magic techniques that precede cinema. This, in turn, raises questions about the place of astronomical images in that same genealogy. Indeed, the earliest records of superimposition techniques are found in trick photography and film manuals instructing the reader in how to create magic illusions (Hopkins 1897; Seeber 1979).

Aesthetics and Science

Recently, the physicist Sabine Hossenfelder (2018) has written at length about how aesthetic judgement drives contemporary scientific research. In addition to arguing that most new theories are speculative and "practically untestable," while still others are "untestable even theoretically," she points to the significant role played by subjective judgement. "When asked to judge the promise of a newly invented but untested theory, physicists draw

196 upon the concepts of naturalness, simplicity or elegance, and beauty. These hidden rules are ubiquitous in the foundations of physics. They are invaluable. And in utter conflict with the scientific mandate of objectivity" (2018, 2). Though Hossenfelder is invested in propagating a dialogue between the natural sciences and philosophy in their shared search for meaning, she is critical of the aesthetic criteria applied to theories in physics.⁷ Significantly, the word "magic" also appears in Hossenfelder's book in the title of her subchapter, "Quantum Mechanics is magic" (2018, 130). Other scientists, however, more openly admit that aesthetic criteria inform their work. For instance, the astrophysicist Trinh Xuan Thuan writes, "In my work, I am often guided by aesthetic considerations that are often attached to those of the rational order" (2011, 134).⁸ Large portions of his book read like translations of the classical (Kantian) aesthetic ideals of truth and beauty into astrophysics. The use of such words as "beauty" and "creation" are abundant in the text, and the words "Idea," "Grand Mystery," and "Eternal truth" are capitalized throughout (Thuan 2011, 152–53).

But even when astronomers do not openly refer to aesthetics as a guiding principle, the final results may nevertheless be aesthetically informed. In their sociological study, Michael Lynch and Samuel Y. Edgerton Jr. examine the role of aesthetic considerations in contemporary astrophotography. They distinguish between work done for the general public and that which the

7 It is interesting to compare this with attempts to include categories from the natural sciences into the humanities, specifically, media studies. For instance, Jussi Parikka writes, "cultural heritage, cultural memory, and social memory are increasingly debated in relation to the planetary, the geological, and the Anthropocene-scenarios involving chemical, geological, and biological processes that displace the concepts and frameworks that are normally associated with 'the social'" (2016, 145).

8 Trinh Xuan Thuan is referring to similar notions employed by the physicist Werner Heisenberg, who preceded him. Hossenfelder also points to the long tradition of physicists who view their work as a quest for beauty (2011, 22). On the history of thinking about the cosmos in terms of harmony and beauty within the discipline of astronomy, see also Herrmann (2017).

astronomers described as being part of an image-processing routine with no aesthetic intent (such as reconstitutions of “noisy pictures”). Nevertheless, Lynch and Edgerton observe that even these latter practices were guided by aesthetic principles: “what aesthetics means here is not a domain of beauty or expression. Instead, it is the very fabric of realism: the work of composing visible coherences, discriminating differences, consolidating entities, and establishing evident relations” (1987, 212).

They conclude:

What we now call science sustains an ancient art: a crafting of natural resemblances; an ‘art’ which is practiced as *mere technique* without ‘aesthetic’ pretensions (in the modern sense). ... [E]xamination of the detailed production of visual displays in science suggests to us that science may have taken over the original sense of *techne*, while professional art has become dissociated from traditional representational concerns. (1987, 214–15)

Cinema as an aesthetic medium has particularly strong historical ties to the notion of “mere technique.” The discourses on cinema in the early 20th century dismissed the new medium’s potential for aesthetic expression precisely on the grounds that it was deemed “mere technique.” Consequently, it became a trope of classical film theory of the first half of the 20th century to defend cinema’s potential as a medium that allows for authorial intervention and creative choices.⁹

We can identify in both astronomy (in its observational and visual form) and cinema a shared affinity for a particular manner of crafting reality. By connecting Canales’ recognition of the ‘cinematographic turn’ in astronomy with Thomas S. Kuhn’s notion of “paradigm shifts” in science, we may ask what kind of a new world view or *Weltanschauung* results from the emergence

9 Important examples of this trope include the seminal works on film by Arnheim (1974), Kracauer (1973), or Bazin (1975).

198 of a cinematographic paradigm in astronomy. Kuhn, who in his seminal book often draws on astronomy to exemplify paradigm shifts in the history of science, asks in one such case: “[c]an it conceivably be an accident, for example, that Western astronomers first saw change in the previously *immutable* heavens during the half-century after Copernicus’ new paradigm was first proposed?” (Kuhn 2012, 11; italics added)

Would cinematographically chartable heavens then signify skies that are not only mutable, but skies made visible—or existent—as a highly *transmutable image*? Can the processual change of the image be ascribed to a technical operation as well as an aesthetic or a “magical” gesture? In the case of the Hubble Space Telescope, Sean Cubitt goes as far as to suggest that “[t]hough built for the tremendous reasons of science, Hubble is a special effects movie” (1998, 65).¹⁰ With regard to digital images more generally, he points out that an indexical relation to the photographed subject is neither an inherent feature of analog cameras nor digital ones, and that the products of both are always translations of photon-scale events into visualizations (Cubitt 2014, 245). This observation recalls Vilém Flusser’s (2001) notion of technical images that are less indexes of the actual physical phenomena they depict than references to the apparatuses that bring those images about. However, the astronomical movies of the Sun discussed in this essay are particularly interesting in that they seem to refer to *a different apparatus* than the one that actually generates them—namely, to the (historical) disposition of cinematographic technology. The references to “the movie theater,” the film strip, and film frames on the SOHO website are readily apparent examples of this phenomenon. But in addition to these references (that I earlier termed as paratextual), and on a more ontological level, the specific use of time-lapse and heterogenous editing techniques suggest that a part of the

10 See also Elizabeth Kessler’s (2012) study of the relation between Hubble’s images and the aesthetics of the sublime.

epistemic repertoire at work here is not only the technical knowledge of movement synthesis—of the succession of singular frames suggested by the vocabulary on the website—but, more importantly, of aesthetic cinematic knowledge, in which the malleability of the passage of time as a visual phenomenon is never solely technical, but rather a subjective, aesthetic process of crafting reality. The result thus reveals a double phantasm at work. On the one hand, there is the phantasm of the cinematographic *dispositif* as imitated by astronomic technology, and on the other, there is the purported visibility of celestial phenomena that ultimately lie beyond the phenomenological scope of our senses and can only be experienced as images.

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