From Stillness (in)to Motion through Astronomical Images: The Cases of Jules Janssen's Photographic Revolver and Josep Comas i Solà's Spectrographic Cinematography

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Abstract

Through the analysis of two case studies — namely, images of Venus' transit across the Sun, captured in 1874 by Pierre J.C. Janssen's photographic revolver, and the advent of spectro-cinematography performed for the first time by Josep Comas i Solà during the solar eclipse of 1912 — the present article seeks to claim and substantiate the strict correlation between photography and cinematic device, recalling what Jean Epstein has defined as 'the lens philosophy'. In fact, both the photographic and cinematic apparatuses, along with the microscope and the telescope, not only surpass the physiological flaws of the human eye, allowing us to see the un-observable, but moreover contribute to the elaboration and development of new philosophical-scientific systems about the Universe, via their images of celestial bodies. I demonstrate therefore how both of the cases under analysis delimit a specific phase of the history of astronomical images. Changes in the latter relate to the production technique and its underlying representation models, thus corroborating the role played by the astronomical image in the permanent dissolution, attenuation, and redefinition of the frontier between photography and film, instantaneity and duration, and the discrete and the continuous.

From its origins, photography has found in astronomy a privileged field of application,[1] especially in regards to astronomical observation and calculation. As early as 1849, Hervé Auguste Étienne Albans Faye — Dominique François Jean Arago's disciple and astronomer in the Paris Observatory — stated 'l'usage le plus important […] de la photographie, dans les observatoires, est de résoudre un singulier problème […] la détermination du temps absolu',[2] reiterating what

[1] The attention paid by François Arago, French astronomer and politician, to the daguerreotype and its relation with astronomy, since its invention, is emblematic. In this regard, see Arago, 'Fixation des images qui se forment au foyer d'une chambre obscure, séance du lundi 7 janvier 1839', *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, 8 (1839), 4–7; and Arago, 'Le daguerréotype, séance du lundi 19 août 1839', *Comptes rendus*, 9 (1839), 250–67.
[2] Hervé Faye, 'Sur les observations du Soleil, séance du lundi 19 février 1849', *Comptes rendus*, 18

will be the prerogative of the French astronomical school. In those years, the scientists in the Paris Observatory were especially dedicated to the meridian observations, that is, to the assertion of the

> instant précis du passage des astres au méridien, derrière les fils du micromètre de la lunette fixée invariablement dans le plan méridien, et de mesurer leur distance aux pôles. On obtient ainsi les deux coordonnées établissant les positions exactes des astres sur la voûte céleste et c'est là la base fondamentale de l'astronomie mathématique.[3]

This strongly complex and delicate operation was what Faye decided to entrust to photography, dismissing the observer in order to elude the fallibility of our own senses. Furthermore, according to Faye, the photographic device would, with great skill and precision, substitute human observation, suppressing any type of personal error; because, as Faye will continue to confidently sustain throughout the years, in this way we would eliminate 'l'anxiété, la fatigue, l'éblouissement, la précipitation, les erreurs de nos sens, en un mot l'intervention toujours suspectes de notre système nerveux'.[4]

Indeed it will be with Pierre Jules César Janssen's photographic revolver that photography will become 'la véritable rétine du savant',[5] as it will allow to capture Venus' passage across the Sun in 1874. This had already been envisaged and foreboded by Faye, his direct predecessor, when he stated on 28 May 1869 in 'Sur l'état de la photographie astronomique en France' that the photographic plate would have come to substitute the human retina.[6]

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It was an exceptional event, both by the rareness of the phenomenon[7] and by the scientific intention underlying its observation. As such, it needed the support of a device of a really high precision. Part of the scientific world, among all and particularly Janssen,[8] recognized this quality in the photomechanical register,

(1849), 241–44 (p. 243).

[3] Faye in Quentin Bajac, '1840–1875: les faux départs de la photographie astronomique', in *Dans le champ des étoiles. Les photographes et le ciel 1850–2000*, ed. by Quentin Bajac and Agnés de Gouvion Saint-Cyr (Paris: Éditions de la Réunion des musées nationaux, 2000), pp. 11–21 (p. 16).

[4] Faye, 'Sur l'observation photographique des passages de Vénus et sur un appareil de M. Laussedat, séance du lundi 14 mars 1870', *Comptes rendus*, 70 (1870), 541–48 (p. 543).

[5] Pierre Janssen, 'La Photographie céleste', in *Œuvres scientifiques*, ed. by Henri Dehérain, 2 vols (Paris: Société d'éditions géographiques, maritimes et coloniales, 1929–1930), ii, 27–50 (p. 50).

[6] Faye, 'Sur l'état de la photographie astronomique en France, séance du lundi 28 mai 1860', *Comptes rendus*, 50 (1860), 965–67.

[7] Venus passes across the Sun twice each 113 years, with an interval of eight years between them.

[8] As declared by Janssen himself: 'Pour moi c'est l'observation du passage de Vénus qui a attiré plus spécialment mon attention sur cette branche [la photographie] si féconde et si délaissée chez nous.' See Janssen, 'Presentation de quelques spécimen de photographies solaires obtenues avec un appareil construit pour la mission du Japon, séance du lundi 22 juin 1874', *Comptes rendus*, 78

the only that guaranteed that result, according to the astronomer Nicolas Camille Flammarion.[9] In other words, this event was the first astronomical occurrence that, in its promulgators' intentions,[10] should have confirmed photography as the main observation and measurement device, because of its ability to overcome the physiologic limitations of human sight.

On 8 December 1874, the aim of the countless expeditions around the world was the optical determination of the exact instant of the entry and exit of Venus' dark disc in that of the Sun. The confirmation of these contacts, observed by two distant observers, along with the data on their position in space, was combined with the comparison of the schedule of those contacts. This would allow obtaining the value of the distance between the Earth and the Sun — i.e. 'la base de toutes les mesures astronomiques. [...] le mètre du système du monde et de toutes les évaluations des distances célestes'. Furthermore, Janssen's gesture of pointing the photographic revolver to the sky to describe the movement of the heavenly bodies corroborates the affiliation of his proto-cinematic device with Galileo's telescope, and with all other optical instruments.[11] It made possible to overcome the physiological shortcomings of the human eye in the perception and capture of the infinitely large and the infinitely small. If the telescope and the microscope explore the dimensions of space, the photographic revolver and the daguerreotype plate, with the several printed phases of Venus' passage across the Sun, allow for a more precise measurement of the distance between the Earth and the Sun. The photographic revolver and the daguerreotype plate also widened the spectrum of analysis of the so-called 'philosophies de la lunette et de la loupe',[12] initiating the studies on movement and its variation in time, and premiered an instrument capable of recording the phenomena in order to perpetuate them in time for continued analysis and future sharing of observations.

Although the photographic revolver was not able to reproduce movement in its dynamism, Janssen's device was strongly connected to its observation and analysis, through a series of photographic images whose function was to decompose in several phases and at regular intervals the passage of a heavenly body across another one. It was an anticipation of the so-called time-lapse cinematography with which real-time condensation is performed, thus allowing for the

(1874), 1730–31 (p. 1731).

[9] Camille Flammarion in Monique Sicard, 'Passage de Vénus. Le Revolver photographique de Jules Janssen', *Études photographiques*, 4 (1998) <http://etudesphotographiques.revues.org/157> [accessed 18 September 2015] (para. 11 of 24).

[10] Despite the forces and means deployed, the photographs taken were actually not able to determine with absolute precision the moment of contact. The results were scarce. For instance, in 1882, by the time of the second passage of Venus across the Sun, the scientific journalist Wilfrid de Fonvielle denounced the failure of the photographic record and how it would further induce the astronomers to abandon the photographic support in favour of the data provided by the old kind of observations. Bajac and de Gouvion Saint-Cyr, p. 19.

[11] Flammarion in Sicard, 'Passage de Vénus' (para. 11 of 24).

[12] Jean Epstein, 'Le Cinéma du diable', in *Écrits sur le cinéma*, ed. by Pierre Lherminier and Marie Epstein, 2 vols (Paris: Éditions Seghers, 1974–1975), i, 335–410 (p. 339).

examination of movements too slow to be observed by the naked eye. Janssen was thereby able to study and follow the phenomenon, in order to analyse their constituent parts and highlight the contacts between the discs of Venus and the Sun. As Janssen wrote,

> le revolver résout le problème inverse du phénakistiscope. Le phénakistiscope de M. Plateau est destiné à produire l'illusion d'un mouvement ou d'une action au moyen de la série des aspects dont ce mouvement ou cette action se compose. Le revolver photographique donne au contraire l'analyse d'un phénomène en reproduisant la série de ses aspects élémentaires.[13]

For these reasons, Janssen considered photography as a precious instrument for scientific research, both by its ability to faithfully fix and reproduce *a posteriori* the observed phenomenon and by its aptitude to overcome the intrinsic limits of human nature. In this regard, Janssen's own words are iconic, when he stated that photography is 'l'œil universel',[14] and added: 'bien supérieure à l'œil humain; car, d'une part, elle garde la trace du phénomène qu'elle a perçu et, de l'autre, dans certains cas, elle voit plus que celui-ci',[15] and also that: 'en raison de cette admirable propriété de nous donner la fixation des images, de les former avec un ensembles de rayons beaucoup plus étendu que ceux qui affectent notre rétine, et enfin de permettre l'accumulation des actions radiantes pendant un temps, pour ainsi dire, illimité'.[16]

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The rapid decline of the daguerreotype, substituted by the wet-plate collodion technique (1851), and later by silver bromide dry plates (1871–1879), has favoured not only the birth of astronomical photography, whose images, until about 1880, fixated the observations made by the human eye, but also propelled the photographic method beyond the possibilities of visual observation. Visual observation will be substituted by the arrival of spectroscopy and photometry, whose images provide information inaccessible to the human eye, like temperature, density and chemical composition, or the measurement of the power and energy that sustain the light sources, giving life to modern astrophysics. Hence, Janssen's quote mentioned above refers inevitably to the ability of the photosensitive medium to capture every electromagnetic radiations, from the infrared

[13] Janssen, 'Présentation du revolver photographique et d'épreuves obtenues avec cet instrument', *Bulletin de la Société Française de Photographie*, 22 (1876), 100–08 (pp. 105–06).
[14] Janssen, 'Discours prononcé à la fête du cinquantenaire de la divulgation de la photographie, le 19 août 1889', in *Œuvres scientifiques*, ii, 166–170 (p. 169).
[15] Janssen in Albert Londe, *La Photographie dans les arts, les sciences et l'industrie* (Paris: Gauthier-Villars, 1888), p. 8.
[16] Janssen in François Launay, 'Jules Janssen et la photographie', in Bajac and de Gouvion Saint-Cyr, p. 26.

to the gamma rays. This ability renders possible not only the measurement of distances between the celestial bodies and the galaxies, but also the time analysis of light, whose remote origin will allow us to see the past of the Universe, its primordial images.

By then Janssen was referring to the study of the nebulae, the eclipses, the comets, and the effect of the photographic irradiation regarding the photosphere, despite the fact that his device was starting to weaken the Newtonian building of absolute time and space — already giving us a glimpse of the possibilities of visual representation of a trans-Cartesian universe: an asymmetric and heterogeneous space-time.

> C'est bien ce que nous montre l'expérience cinématographique, qui n'est point si isolée d'observations jugées plus scientifiques qu'elle ne puisse être confirmée par ces dernières. Par exemple, telle nébuleuse, nous la voyons aujourd'hui dans son état d'il y a exactement un siècle. L'expansion de l'univers peut faire que cette galaxie et notre globe s'éloignent, l'une de l'autre, tous deux animés d'une vitesse égale aux trois quarts de celle de la lumière. Au bout d'un an, nous pourrons voir la nébuleuse dans un état antérieur, datant de cent ans et six mois d'après notre chronologie. Donc, au cours du laps de temps, pendant lequel, nous, nous aurons vieilli en vivant une année dirigée du passé vers l'avenir, la nébuleuse, elle, aura rajeuni sous notre regard, dévécu six mois dirigés de l'avenir vers le passé.[17]

Returning to the object of this analysis, i.e. the astronomical images produced by Janssen's photographic revolver, two things are evident. On the one hand, the photographic record has confirmed once again the indexical value, the presumed objectivity of the space-time fragment taken from the observed reality. On the other hand, it contributed to set the basis for a new visual practice, able to describe 'un univers mouvant, découpé en tranches de 72 secondes, celle qui, décomposant les phénomènes, ne les percevrait que par intermittence'.[18] Janssen's device, in which the continuous and the discontinuous overlap, and the analytical photography of movements anticipates the motion and prefigures the synthesis of movement itself, redefining the status of the photomechanical image. Janssen forecasts the advent of the kinetic, of the movement understood as a flux composed by discrete units, through which time is conceived in its atomistic nature, in that each element is marked by a clock's mechanical system. Moreover, the clock itself provided, by means of the hands movements, the parcelled model of time, whose passage was seen as the sum of moments quantitatively identifiable. Clocks and metronomes were used even in scientific laboratories as essential instruments to study and measure the flow of life, its constituent temporal units.[19] The science of the second half of the nineteenth

[17] Epstein, 'Le Cinéma du diable', pp. 377–78.

[18] Sicard, *La Fabrique du regard* (Paris: Éditions Odile Jacob, 1998), pp. 164–65.

[19] Despite the great relevance of Muybridge and Marey's studies, I will not delve in the exam of the technical devices and the countless experiences of Muybridge's serial photography and Marey's

century was committed to the attempt of finding devices that could photograph time, rendering it visible, ductile, measurable, and representable through the mathematization of movement into qualitative and quantitative data that could be scientifically verified.[20]

In this regard, Janssen was the first, just as Marey declared,[21] to transform photography into a kind of recording clock capable of simultaneously perform the indexation of sight and the measurement of time, mechanically combining the view of the observed phenomenon with the detection of its fundamental time units, by means of immobilizing and decomposing the movement and its duration.

Therefore, the photographic revolver's double-faced nature was configured in the observer's experiential horizon. The 'pregnant instant'[22] coexists with the impression of the duration in which the kinetic of the photographic image is given by the circularity and repetition of the frames, ideally infinite, while the photographic nature of the revolver's images succession is given by the discontinuous pose, by the immobility of each photograph. To the fixity of the frame is added the transition of a long exposure, thus combining the pose with the view and the immobility with the return to movement. What's more, the device conceived by Janssen possesses and displays a dual overlapping, both technical and epistemological. Although Janssen, during the Congress of the Union Nationale des Sociétés Photographiques de France which took place in Lyon in July 1895, had stressed the distinction between the 'analytical photography of movements' of Marey's chronophotography — a scientific procedure perfected and derived from the photographic revolver — and the 'animated photography' from the Lumière Brothers' projections — the naturalistic reproduction of pictures in motion —, both devices presented the Maltese cross gear, responsible for the intermittent progression of the photosensitive surface,[23] and the shutter, whose

chronophotography, in what concerns the study of the relationship of the space-time coordinates with the physiological movements whose dynamic and mechanism they intended to analyse.

[20] In those years, Marey's research on the study of movement have contributed to the process of mathematization of physiology, raising a considerable interest in the scientific (Hermann von Helmholtz and Charles Fremont) and industrial (Frederick W. Taylor and Frank B. Gilbreth) fields. This interest focused in the measurement of the preservation/energetic expenditure of the labour force and their harmonisation with the movements of the industrial machines. See Anson Rabinbach, *The Human Motor* (Berkeley: University of California Press, 1992).

[21] 'C'est M. Janssen qui le premier, dans un but scientifique, imagina de prendre automatiquement une série d'images photographiques pour représenter les phases successives d'une phénomène. C'est donc à lui que revient l'honneur d'avoir inauguré ce qu'on appelle aujourd'hui la *Chronophotographie sur plaque mobile.*' Étienne-Jules Marey, 'Chronophotographie sur plaque mobile', in *Le Mouvement* (Paris: G. Masson Éditeur, 1894), pp. 102–23 (p. 102).

[22] Here I refer to Lessing's notion, postulated in Gotthold Ephraim Lessing, 'Laoköon: oder über die Grenzen der Malerei und Poesie' (Berlin: Christian Friedrich Voss, 1766) and resumed by Jacques Aumont, *L'Œil interminable: cinéma et peinture* (Paris: Librairie Séguier, 1989) and Roland Barthes, *L'Obvie et l'obtus* (Paris: Éditions du Seuil, 1982), among others.

[23] While the photographic revolver had a sensitive, circular plate, Lumière's cinematograph used perforated film.

function is to prevent the passage of the light during the advancement of the support. As mentioned above, the proximity is not limited to what concerns the components and the operation of the devices in question. It also encompasses two distinct paradigms related to the techniques and the visual practices implied.

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Indeed, Janssen's astronomical photography redefined the image status not only in respect of the production technique, due to the unprecedented conjunction of heliostat, telescope and daguerreotype, but also in the profound change related to the scopic regime — that is, the new dialectic relationship between the geometric optics of the camera obscura and the onset of the physiological optics of the consecutive image.[24] As far as the first visual model is concerned, Janssen's device shares with the camera obscura one of its main functions: the indirect observation of the Sun. Just as Johannes Kepler and Sir Isaac Newton used the camera obscura to avoid the direct observation of the Sun during its analysis, Janssen's device was also designed to capture the inscrutable, the unobservable. In both cases, the aim was to capture and concentrate sunlight almost as if they were mirrors capable of returning with absolute clarity, according to the mechanisms of propagation of the light beam and the laws of optical transmission, 'the light of reason, not the potentially dangerous dazzlement of the senses by the light of the sun'.[25]

The camera obscura model performed a separation between the act of sight and the observer's body, excluding the deceiving senses of the capture of the phenomenon, so that the subject could go from organizer to witness in the process of the objective and mechanical register of the observed reality. The observer's body did not intervene, his physical position before the observed phenomenon was irrelevant, since the trust was placed solely in 'a disembodied cyclopean eye, detached from the observer',[26] able to establish a rational space, a transcendental representation of the world, away from the corruption of the senses and the uncertainty and confusion of the human eye. As aforementioned, the photomechanical image in the astronomical field was also always conceived within a device that, since Faye and his project to bind photography and electromagnetism,[27] intended to do without the intervention of the observer's senses, since 'la fatigue oculaire, le travail analytique de l'esprit ou des maladresses de la main'[28] could harm the work of the scientist.

Faye's project and Janssen's device to substitute the human retina by the pho-

[24] For a more complete presentation of the concepts related to the optical regime of the camera obscura and to the physiological optics of consecutive images, I refer to Jonathan Crary, *Techniques of the Observer* (Cambridge, MA: MIT Press, 1990).
[25] Ivi, p. 44.
[26] Ivi, p. 47.
[27] Faye in Bajac and de Gouvion Saint-Cyr, p. 17.
[28] Bajac, ibidem.

tographic plate referred inevitably to the objective and immaterial eye of the camera obscura. Furthermore, the photographic revolver and the attempt to decompose the movement, slowing it down and condensing it, somehow attested the assertion of the observer's physical subjectivity as the active place where, and through which, the visual representations take shape. As the words of Jonathan Crary corroborate, from the beginning of the nineteenth century 'the visible escapes from the timeless order of the camera obscura and becomes lodged in another apparatus, within the unstable physiology and temporality of the human body'.[29] Actually, the photographic revolver was not only an autonomous optical device, a neutral apparatus of instantaneous transmission of data proceeding exclusively from the observation of an object. On the contrary, the observer's presence became mandatory to the interpretation of the observed phenomenon, constituting the basis of the visual experience, the individual who produces the movement and the passage of time, in synergy with the machine of which he became an integral part.

If, during the seventeenth and the eighteenth centuries, the human being made optical instruments that reproduced the principle of the camera obscura — such as the microscope and the telescope for example —, proposing its monocular, motionless and immaterial vision, then from the advent of the photographic revolver it was no longer just the human being using a device made by himself, but the observer's own body using and interacting with the machine, guaranteeing the succession of images and his experience of time.

In fairness, it will be the cinematograph, this automaton of sight whose mechanism ensures for the first time in history the photographic inscription of time and the simultaneous recording of space that will go beyond this apparent overlapping, displaying a new image of the universe, the inconsistency of the dichotomies instantaneous/duration, discrete/continuous. The cinematograph: this sort of brain-machine able to reveal in the continuity of the projection a subjective transfiguration of a more true discontinuity and, at the same time, in discontinuity an arbitrary and mechanical interpretation of a fundamental continuity. Paraphrasing Jean Epstein, it is then discovered that the cinematic continuous and discontinuous are inexistent, since

> [l]e cinématographe nous indique que le continu et le discontinu, le repos et le mouvement, loin d'être deux modes de réalité incompatibles, sont deux modes d'irréalité facilement interchangeables [...]. Il n'y a pas plus d'exclusive entre eux, qu'il n'y en a entre les couleurs d'un disque à l'arrêt et le blanc du même disque en rotation. Continu et discontinu, repos et mouvement, couleur et blanc jouent alternativement le rôle de réalité, laquelle n'est, ici comme ailleurs, jamais, nulle part, autre chose qu'une fonction […].[30]

[29] Crary, p. 70.
[30] Epstein, 'L'Intelligence d'une machine', in *Écrits sur le cinéma*, i, 255–334 (p. 281).

It was no longer a matter of understanding the superficial continuity of mundane phenomena, or of probing the molecular and subatomic discontinuity, because the Universe is not made of matter but of energy, as stated by Epstein.[31] The cinematic device, in accordance with the scientific materialism of the second half of the nineteenth century of which it derives, enables the visualization of new shapes and new relations that break with the homogenous, non deformable and isotropic continuous of the Newtonian conception of the Universe. In other words, it is as if the advent of the cinematograph had revealed the inconsistency of the classical conception of space and time, seen as distinct and unchanging domains in which movement is measured in regard to a fixed and absolute reference system. The inconstant mobility of the forms that run on the cinematographic screen and the dilation and/or reduction of the extension and succession of recorded phenomena reveal the most intimate nature of matter, whose consistence is no other than energy, located within a certain, limited space-time section, perceptible and understood by our senses.

> Le cinématographe nous montre que la forme n'est que l'état précaire d'une mobilité fondamentale, et que, le mouvement étant universel et variablement variable, toute forme est inconstante, inconsistante, fluide. Le solide se trouve tout à coup menacé dans sa suprématie ; il ne représente plus qu'un genre particulier d'apparences propres aux systèmes d'ordinaire expérience et d'échelle humaine, qui sont à mouvement constant ou faiblement et uniformément varié.[32]

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By then the third phase of space observation was taking shape: after drawing and photography,[33] the third great advance in astronomy was in cine-photographing the spectra of the stars. During the first years, however, the use of cinematic devices in the astronomical field did not achieve great results immediately.

I mainly point out the observations made by Josep Comas i Solà, director of Fabra Observatory in Barcelona, who during the solar eclipse of 1900 in Elche, performed a series of photographs of the corona and of the spectrum of the chromosphere with a prismatic camera[34] — a conventional photographic camera with a prism attached to the lens. Furthermore, during the solar eclipse of 30

[31] Epstein, 'Le Cinéma du diable', ivi, pp. 335–410.
[32] Ivi, pp. 403–04.
[33] This was a preponderant phase of the scientific representations in the astronomical field. It encompasses the drawings of the lunar phases observed by Galilei through a telescope and published in Galileo Galilei, *Sidereus Nuncius* (Venice: Tommaso Baglioni, 1610), and the work of Nasmyth and Carpenter, published in James Nasmyth and James Carpenter, *The Moon Considered as a World, a Planet and a Satellite* (London: John Murray, 1874). In the later case, the Moon images were accomplished by photographing it from different perspectives and building plaster scale models of the satellite from drawings drawn by Nasmyth himself.
[34] M. Encarnació Soler i Alomà, 'Va filmar Chomón I'Eclipsi?', *Cinema Rescat*, 15 (2004), 11–16 (p. 12).

August 1905, Comas i Solà went even further and, besides the photographs of several chromospheric spectra, made some images with 'un cinématographe de M. Gaumont, dans lequel [il avait] placé devant son objectif de Goerz un prisme de M. Mailhat', adding '[o]n doit conseiller ce procédé spectro-cinématographique comme un puissant auxiliaire des autres observations spectroscopique.'[35] Yet, Comas i Solà's big astronomical success was achieved later with the eclipse of 1912, when he adapted two equilateral prisms to the lens of a normal, commercial camera 'in order to record with a convenient temporal resolution the occurrence and evolution of the flash spectrum of the solar chromosphere'.[36] For the first time, the cinematographic image was used not only to document eclipses, comets' movements, sunspots and every dynamic phenomena concerning positional astronomy, but also to identify the different energies of the electromagnetic spectrum. This assisted in the transition 'to the new astrophysical studies, process in which the eclipses of the beginning of the century (1900, 1905 e 1912) were a relevant driving factor (Ruiz, 2009)'.[37]

Comas i Solà's cinematic prismatic camera and his footage of the flash spectrum, performed with a pace of five photograms per second for a total of about one hundred images,[38] confirmed the access to a new universe that questioned Kantian categories of space and time. Now the cinematograph had the power to challenge the space-time relationships conceived for centuries as fixed and absolute entities. It was therefore enough to modify the time of cinematic representation to destroy the usual experience of things. Or, making mine Epstein's words, changing the time of recording and projection sufficed to reveal a '[m]onde profondément fluide, d'où la permanence des formes a disparu dans un espace qui ne connaît plus de symétrie et dans un temps qui a cessé d'être uniforme'.[39] This is the reason why nothing is motionless in the universe, everything changes, and everything is transformed.

Just as previously with the photographic revolver, the astronomical image came to redefine once more the already subtle frontier between photographic and cinematic, whose statuses were even questioned by the spectrographic cinematography. These new astronomical shootings showed features of the observed phenomena that the human body could not and cannot experience, not only because they insinuate themselves in the folds of time, inconspicuous to the physiology of our eyes, but because they give us back arbitrarily encoded images from outer space.[40]

[35] Josep Comas i Solà, 'Observations sur l'éclipse totale du Soleil du 30 août 1905, séance du lundi 16 octobre 1905', *Comptes rendus*, 141 (1905), 616–17 (p. 617).
[36] Salvador X. Bará Viñas, 'Innovación tecnolóxica e astronomía social na eclipse de sol do 17 de abril de 1912 no Barco de Valdeorras', *Revista Real Academia Galega de Ciencias*, 31 (2012), 55–68 (p. 56, my translation).
[37] Ivi, pp. 59–60 (my translation).
[38] Ivi, p. 58.
[39] Epstein, 'Esprit de cinéma 1946–1949', in *Écrits sur le cinéma*, ii, 11–128 (p. 107).
[40] As de Gouvion Saint-Cyr reminds us: 'Le pied sur la lune, la tête dans les étoiles…', in Bajac and de

It would be possible to assert that with the spectrographic cinematography nothing of what we see will ever be within our sight's reach, both by the huge distance between us and the observed celestial object, and by the progressive separation between the body and the organ of sight, be it human or artificial. In the measurements of the electromagnetic spectrum, within balloons in the 1930s and within artificial satellites from the 1950s onwards, we have seen observation devices being placed beyond the atmosphere to also capture the radiation that does not reach the terrestrial observatories. Thus, a vision without sight is outlined, in an automatism of perception that ousts the body from its role of fundamental referent of the human action as centre of observation and measurement of space. Furthermore, the transcription of invisible radiations through a code and a chromatic scale, intentionally developed to render intelligible the data from spectral range explorations, constituted the first step towards the total computerisation of image production and reception. This is why the simulation mechanism that brought the eye closer to the photomechanical representation will leave its position to a substitution process, by which the machine will produce images by itself, with no physical mediation whatsoever of a human being.

In this sense, the technical progress of the astronomical image will put forth the implementation of a new vision, of a new image — the electro-numerical — whose elaboration and transmission will envelop the Earth in an infographic net in which space and time will implode in the ubiquity and concomitance of the teletopological phenomenon,[41] in the synthesis between the photographic and the cinematic,[42] in which the instantaneousness of the event and the duration of the transmission overlap. Otherwise, how do we define the images of 18 March 1965 of humanity's first EVA[43] performed by the cosmonaut Alexey Arkhipovich Leonov, whose production, transmission and reception involved, respectively, photomechanical, radio-electronic and broadcasting processes? And above all, what is the place of the earthly observer who admires the Globe spinning behind the cosmonaut?

Gouvion Saint-Cyr, p. 41: 'Telle onde lumineuse n'ayant pas de nom — donc pas de représentation — dans notre langage visuel, il convient de lui attribuer un code qui, par rapport à d'autres sources de rayonnement, permette de situer l'astre dans l'Univers. On comprend alors pourquoi il devient désormais illusoire de dresser des cartes du ciel sans les accompagner de légendes précises.'

[41] Paul Virilio, *La Machine de vision* (Paris: Éditions Galilée, 1988).

[42] As Mitchell writes: 'The first cameras in space used photographic film, which was automatically developed and scanned for transmission to Earth.' See Donald P. Mitchell, 'Soviet Space Cameras', <http://mentallandscape.com/V_Cameras.htm> [accessed 15 July 2015]. For a deeper understanding of the history of the soviet missions and for technical information about the space photographs and shootings, visit the websites <https://donpmitchell.wordpress.com/> and <http://mentallandscape.com/> [accessed 30 September 2015].

[43] EVA stands for Extra Vehicular Activity.