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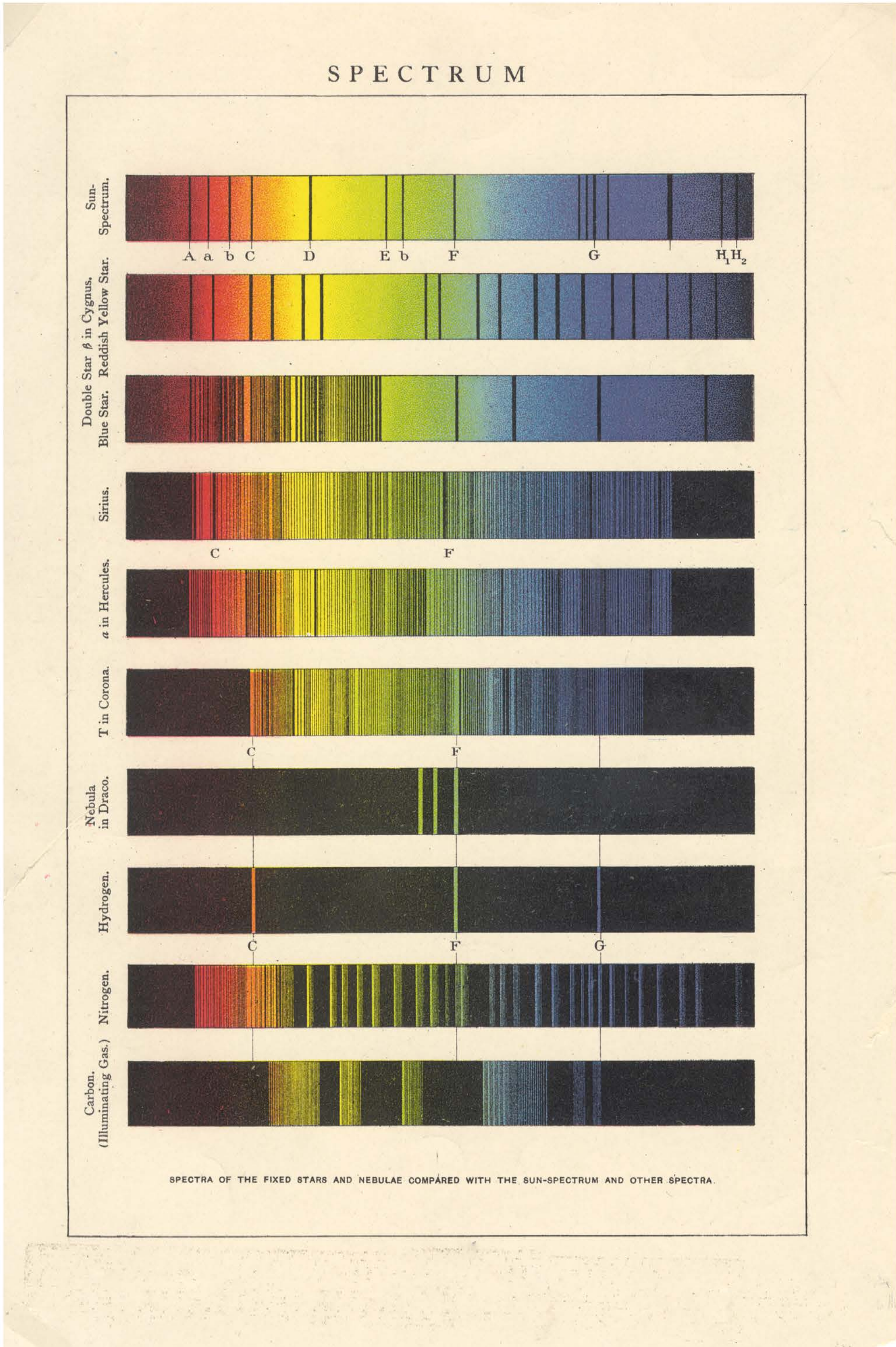

SPECTRA OF THE FIXED STARS AND NEBULAE COMPARED WITH THE SUN-SPECTRUM AND OTHER SPECTRA.

ESSAY

THE LINEAGE OF LIGHT
PHOTOGRAPHY BEYOND THE VISIBLE SPECTRUM

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From its very beginnings, photography has sought to "grasp the ungraspable [and] visualize the invisible."[1] For media theorist Vilém Flusser, technical images are produced through apparatuses that "consolidate particles around us."[2] Particles can be understood as invisible bits of information, as well as electronic data captured and processed by devices capable of visualizing what humans cannot see, and sometimes cannot fully conceptualize.

Scientists and artists began experimenting with photography in the nineteenth century, seeking to expand its sensitivity to electromagnetic wavelengths outside the range of visible light. When it came to photography's capacity to "freeze" time — a term that only started making sense post-Muybridge — attempts were made to accumulate light over extensive periods, thereby recording far more information than any eye, aided or unaided, could ever see. Corey Keller, curator of photography at the San Francisco Museum of Modern Art, has cited the English astronomer Richard Proctor, who in 1883 referred to photography's extraordinary vision as the "eyes of science,"[3] with a deliberate emphasis on the plural. Proctor argued that with "the eye of keenness, the eye of patient watchfulness, and the eye of artistic truth," photography would safeguard astronomers from error and "detect truths which otherwise would escape us."[4]

Photography has willingly lent itself to numerous fields — so many now that the more photography there is around us, the less we know what photography actually is. Given this dichotomy, it is time we reconsider the medium's multiple faces. Vilém Flusser will, again, be of tremendous help here. He attempted to delineate the "consciousness of a pure information society,"[5] and foresaw that the universe of technical images would bring forth a cultural revolution, one that is technical before it is political. It is now clearly evident that this somewhat dystopian vision has not been contradicted. Photography's technological advances and growing number of uses hint at a future for the medium in a society on the verge of becoming predetermined by technology. This is Flusser's vision of a "pure information society," where some machines inform and shape human knowledge and others significantly augment human vision. This discourse aims to re-conceptualize the uses of contemporary scientific photography as artistic — or what Flusser called "informative." It is our hope to call out new possibilities for photography as art, in conjunction with imaging technologies in fields like biology or physics, particularly astronomy. After all, photography has always been an expanding medium.

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For many, our science appears in a new and pleasant light, now that it can be described and explained in relation to photographic art, whose products are valued so greatly and treated with such regard in every family. [6]

— *H. G. van de Sande Bakhuyzen*

Around the turn of the twentieth century, many scientists sought to render the invisible visible. Among the discoveries that changed — or made — the world were Wilhelm Röntgen's imaging technique, now called X-ray photography, and the Curies' and Henri Becquerel's employment of photographic plates to detect what were

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01 *Spectra of the Fixed Stars and Nebula Compared with the Sun, Spectrum, and Other Spectra, 1922.*

02 *Orion Nebula*, NASA, 2010

then relatively unknown kinds of radiation that existed beyond the visible spectrum. Those discoveries laid the foundations for what medicine now calls positron-emission tomography (PET). During the same period, numerous astronomers from observatories around the world turned their efforts to the skies and sought to produce reliable images of distant stars.

Astronomy was one of the first disciplines to eagerly adopt photographic technologies. It did so by enlisting not only the camera but also photographic concepts in pursuit of producing imagery of the heavens. Photography certainly contributed to the sheer popularity of astronomy, boosting our level of enchantment with the sky by supplying visual data to supplement a developing curiosity about the unknown. However, there is a problem: Is the outer space exposed by photography actually as magnificent as we have come to see and know it? As it so happens, celestial bodies look nothing like how we imagine them. As Saskia Asser puts it "Photographic spectral analysis, which has become part of astronomical research since the late nineteenth century, has the visual expressiveness of a barcode."[7] In a reversal of Proctor's nineteenth-century assertion, Bruno Latour writes in his article for the exhibition catalogue of *Iconoclash: Beyond the Image-Wars in Science, Religion and Art* that "the more the human hand can be seen as having worked on an image, the weaker is the image's claim to offer truth."[8] Latour argues that all claims of objectivity and veracity by manipulated images are weak. And the same is true of science:

There, too, objectivity is supposed to be acheiropoiete, not made by human hand. If you show the hand at work in the human fabric of science, you are accused of sullying the sanctity of objectivity, of ruining its transcendence, of forbidding any claim to truth, of putting to the torch the only source of enlightenment we may have.[9]

Latour goes even further in stating that scientists also employ and manipulate images in order to generate "scientific objectivity," or, at least, an enchanting illusion. If we wish to be more forgiving:

We treat as iconoclasts those who speak of the humans at work — scientists in their laboratories — behind or beneath the images that generate scientific objectivity. I have also been held by this paradoxical iconoclash: the new reverence for the images of science is taken to be their destruction.[10]

So, it is evident that both scientists and artists manipulate images, thereby impinging on their accuracy and veracity. But what are the motivations at work here? It is not our intention to argue for artistic freedom of expression over scientific accuracy. Instead we wish to point out that there are instances — for example, in astronomy — when manipulation is vital to our understanding of physical phenomena. While we may be able to observe radiant stars directly, planets do not emit light but reflect it. Therefore, we would not be able to view images of many of the planets, even in our own solar system, if it were not for visual manipulation. We may have become accustomed to thinking about Mars as the red planet thanks to the rusty color of its surface, but for fainter objects, such as gaseous nebulae and various other parts of galaxies, for which very bright images do exist, the case is very different. Even upon observing these bodies with sizeable telescopes, the human eye cannot and will not distinguish any color since they lack the necessary brightness. How, then, has imagery of celestial objects become so suffused with color? The answer is simple. In order to make colors appear to the human eye, these mirages are constructed out of compound images, often taken with three different color filters to simulate human vision.

It is also noteworthy that the color in such celestial imaging does not indicate temperature, and its appearance to the human eye is completely different than it is to machines that record emissions: "The human eye is simply not built to extract useful information from a spectrum with only emission lines. In faint objects… [some features are] not even visible."[11] Astronomy professor Dr. Huib Henrichs writes that, "to our eyes, the color of the sun is white, whereas the hydrogen lamp looks purple-pink."[12] Further, it makes no sense to "aim for a picture of 'true' colors since there is a lack of pictorial information altogether." Instead, Henrichs notes, in order for an astro-photographer to produce an image, "narrow-band filters are used and combined strategically so that the specific properties of the light source become evident."[13] The semi-arbitrary manner in which scientists determine color is not unique to astrophotography. Similar procedures are in place in many other fields where researchers fabricate imagery to make it digestible and to make it suitable for revealing information. That is, they use colors strategically instead of accurately or objectively. This is almost always the case in imagery of substances and objects beyond the boundaries of human vision.[14]

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The common practice of adding colors to stars enhances the human apprehension of distant galaxies. The Hubble telescope and other satellites enable us to reach impossible resolutions of events taking place at unimaginable distances, over many thousands of light years away. We no longer expect images in the natural sciences to serve only as empirical instruments but as tools for the creation and ordering of knowledge. Isn't this what we elsewhere call data visualization? Clearly, when it comes to capturing visual data invisible to the human eye (i.e., when generating images in nanotechnology or microbiology from structures too small for unaided eyes to see), one should keep in mind that visualizations often — if not always — replace the "original." Scientific images, be they photographic or not, are also almost always manipulated, and yet they still take advantage of photography's "privileged" connection to the real.

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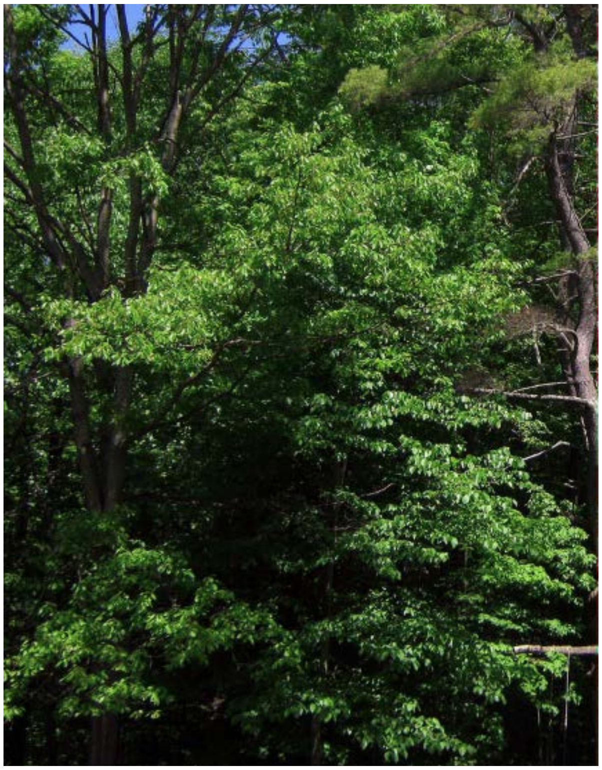

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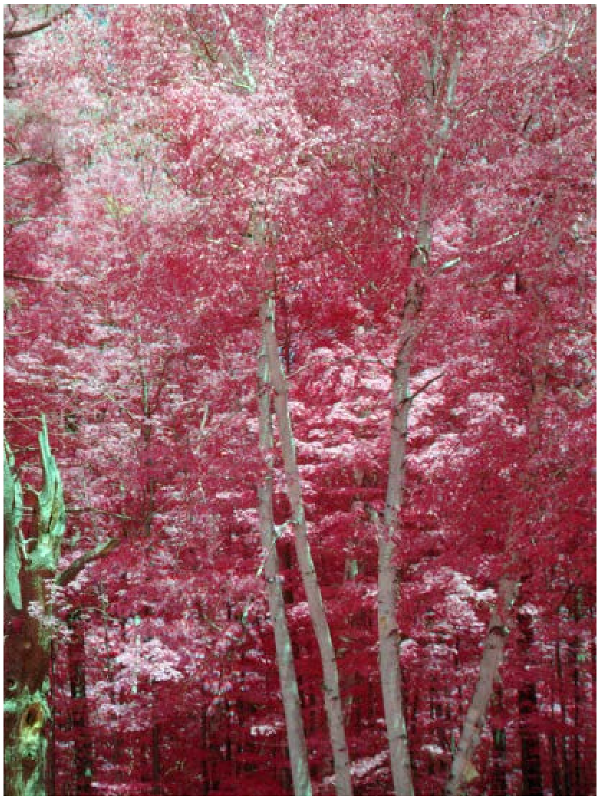

Oliver Grau and Thomas Veigl bring up a crucial point in their introduction to *Imagery in the 21st Century*:

In science, the image has become an independent tool of thought. Images count as arguments and proofs; they document and project, model and simulate, show things visible and invisible… although debates are now surfacing in this discipline about the veracity of their new image worlds, images are still being utilized as arguments, while the extremely artificial conditions under which the images are generated are hardly analyzed at all.[15]

But can similar tendencies be observed elsewhere, in various other techniques closer to home, and in technologies that help capture invisible dimensions? For example, what about the ways in which radiation and waves are measured and then visualized?

Having established that the way astronomy makes use of photographic imagery is mostly arbitrary, let us now look at another field that is regaining currency: thermography. Near-infrared photography has been a key tool for planning at industrial and governmental levels. It is often used on airplanes and satellites by militaries and law enforcement agencies; it is used by NASA, as well as for agricultural and ecological assessment. As a result there has been a plethora of new infrared and thermal technologies to surface. One recent example is Infragram developed by Public Lab. Infragram allows the general public to monitor their environment through verifiable, quantifiable, citizen-generated heat data. "Just as photography was instrumental to the rise of credible print journalism," the Public Lab researchers claim that "inexpensive, open-source data-collection technologies democratize and improve reporting about environmental impacts."[16]

The Public Lab group notes on their website that scientists using remote sensing technologies quickly learned, that by combining visible and infrared data, they can reveal critical information about the health of vegetation.[17] This technology has been in use since 1972, when the first Landsat satellite was launched. Only now, however, are remote sensing and thermography practices becoming popularized and put to common use. The Public Lab group presents enticing images, offering the layperson an opportunity to not only become an explorer of their surroundings, but to see the invisible by fabricating images in a simple, inexpensive way.

Infragram produces two separate images, one made from visible light and one from infrared radiation. The composite image — using the normalized difference vegetation index — highlights the difference between red and infrared wavelengths that are reflected from vegetation. These false-color photos can then teach us about the environment and the health and vigor of plants and landscapes. The Public Lab invites gardeners to "analyze, tweak, modify, and re-analyze their imagery to their heart's content, extracting useful information about plant health and biomass assessment along the

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04 Infagram Photograph by Chris Fastie

05 Infagram Photograph by Chris Fastie

06 Infagram Photograph by Matthew Lippincott

Courtesy of MIT Public Lab

way."[18] This is one simple use of remote sensing, and it is indicative of the direction photography is taking. The more technology there is for capturing and modifying radiation, the wider the definition of photography becomes.

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Photography is losing its traditional dependence on light — so should we still call it photography? After all, the medium did start — etymologically and historically — as the process of recording, registering, and writing with light. However, there were many ideas regarding how images might be captured and fixed prior to photography's emergence. According to photography historian Geoffrey Batchen, "At least twenty people from seven European countries entertained the idea of photography between about 1790 and 1839."[19] Some of those ideas were less developed than others when it came to specifying how that permanent fixation of imagery on surface would take place. Wouldn't we be better off simply using the term "ray tracing?" Surely this is not an inaccurate description of what photography is today. Or is this merely a prediction? Is it straightforward to suggest that in order to make an image by mechanical means, the tracing of a ray (and not even the fixing of it) would suffice for us to call it photography? The diversity of imaging technologies prevents us from speculating to what extent — and whether at all — the medium of photography will continue to be loyal to its defining character — light.

If that is indeed the direction in which photography is heading, what does this mean for our own unprivileged human vision? For we cannot trace — or see — most of the rays and forms of radiation that surround us. We conclude with Flusser's words once again, revealing his insight about "natural" vision and the possibilities that photographs, or technical images, open before us:

What we find difficult to see (e.g., a magnetic field, unless we use iron filings) is, from its standpoint, just another possible function. It transforms the effects of photos on molecules of silver nitrate into photographs in just the same way: blindly. And that is what a technical image is: a blindly realized possibility, something invisible that has blindly become visible.[20]

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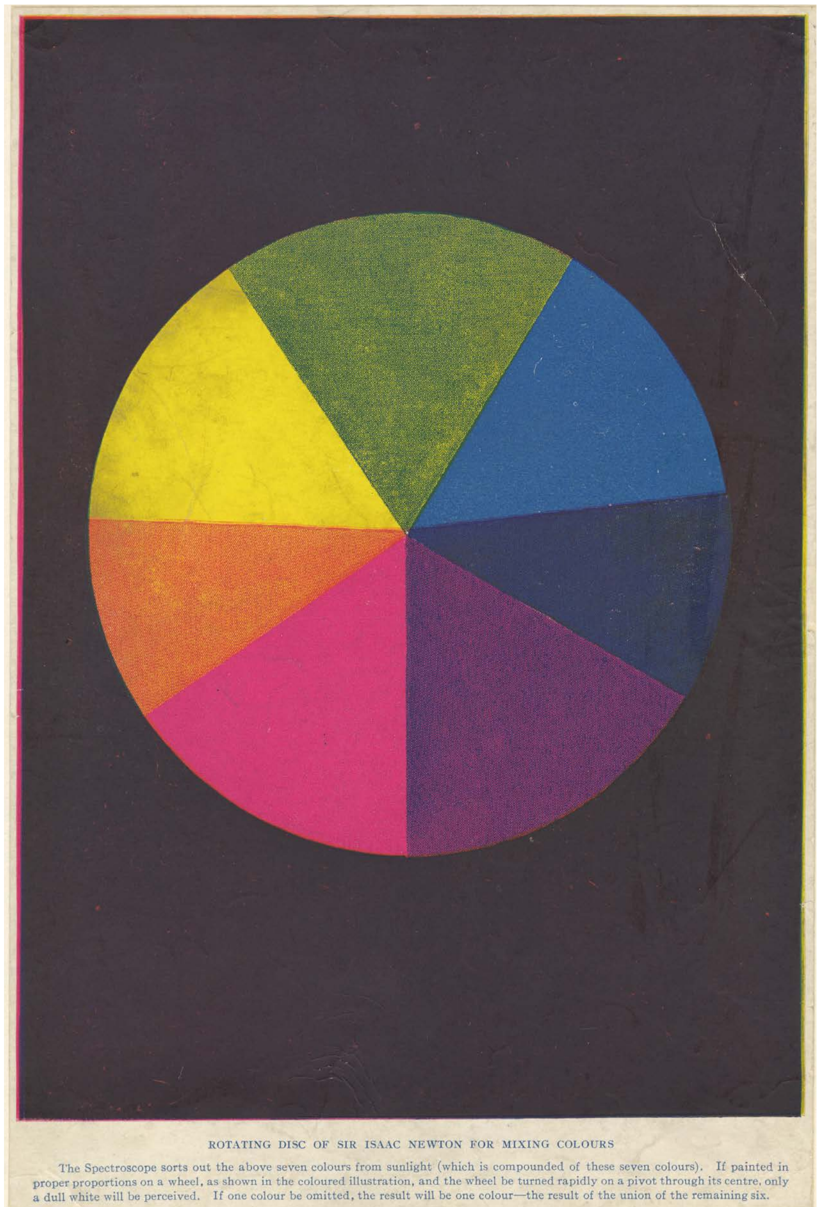
1. Vilém Flusser, *Into the Universe of Technical Images*, trans. N.A. Roth (Minneapolis: U. Minnesota Press, 2011), 16.
2. Ibid.
3. Corey Keller and San Francisco Museum of Modern Art., *Brought to Light: Photography and the Invisible*, 1840-1900 (San Francisco: San Francisco Museum of Modern Art ; In assoc. with Yale U. Press, 2008), 34.
4. Ibid.
5. Flusser, *Into the Universe of Technical Images*, 4.
6. Keller and San Francisco Museum of Modern Art., *Brought to Light: Photography and the Invisible*, 1840–1900, 31.
7. Saskia Asser, *First Light: Photography & Astronomy* (Amsterdam: Huis Marseille, 2010). 123.
8. Bruno Latour and Peter Weibel, eds., *Iconoclash: Beyond the Image Wars in Science, Religion, and Art* (Karlsruhe, Germany: ZKM, 2002), 18.
9. Ibid.
10. Ibid.
11. Asser, *First Light: Photography & Astronomy*: 45–47.
12. Ibid., 46.
13. Ibid., 47.
14. Here, it is interesting to note the insightful observations of legendary American computer scientist Jim Gray and Johns Hopkins astronomy professor Alexander Szalay in "The World-Wide Telescope," *Communications of the ACM* 45, no. 11 (2002). Gray and Szalay are famous for porting the massive star-mapping project called The Sloan Digital Sky Survey onto the internet. According to them, scientists adopt certain patterns of looking at the data they acquire "using visualization packages to 'see' the data as 2D and 3D scatter plots." Scientists run queries using data mining and visualization tools and then examine data sets looking for central clusters to analyze, recognize, classify, and catalogue objects, and only "when they recognize something anomalous do they go back to the source pixels." Hence, most source data "is never examined directly by humans" and patterns used to visualize and analyze the massive amounts of data are most likely to be replicated and fixated, until an error or an anwomaly is found.
15. Oliver Grau and Thomas Veigl, eds., *Imagery in the 21st Century* (Cambridge, Mass.: MIT Press, 2011), 12–13.
16. Public Lab. Infragram page on Kickstarter. http://www.kickstarter.com/projects/publiclab/infragram-the- infrared-photography-project. Last accessed on July 1, 2013
17. http://publiclab.org/wiki/near-infrared-camera Last accessed on July 1, 2013
18. Ibid.
19. On that note, see Batchen's extensive overview in Geoffrey Batchen, *Burning with Desire: The Conception of Photography* (MIT Press, 1999). ix.
20. Flusser, *Into the Universe of Technical Images*: 16.
21. Spectra of the Fixed Stars and Nebula Compared with the Sun-Spectrum and Other Spectra. 1922. Halftone photomechanical print. Courtesy of Library of Congress, Prints and Photographs Division.
22. Rotating Disc of Sir Isaac Newton for Mixing Colours. 1922. Halftone photomechanical print. Courtesy of Library of Congress, Prints and Photographs Division.



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07 *Rotating Disc of Sir Isaac Newton for Mixing Colours*, 1922 [22]