

Wrong Spectrum

Color space should hold together material and perceptual realities, only-quantifiable and only-qualifiable experiences. Anne Truitt identifies this space as a unity of opposites—"the flux of color" magnetized by "the severe *logos* of structure."¹ Where others have framed the understanding of color abstractly, as an observable index of the unseen,² Truitt places experience and understanding within a continuous whole.

Comparing one patch of light with another, the range of color experience is measured in equivalences, modeled as a theoretical space—no eyes required. The spectral basis of this space outlined in Newton's "*Opticks*" tends to make us to think of color as seeing-by-wavelength,³ but an infinite number of alternative ways of mapping color should exist in principle.⁴

Picture the rainbow as a boundary or contour, rather than as a secondary image or surface layer. Observing children's fascination with "the way colors shimmer in subtle, shifting nuances (as in soap bub-

bles)," making "definite and explicit changes in intensity," Walter Benjamin described an intuitive understanding of the visible spectrum as "fluid, the medium of all changes, and not a symptom" of the material world.⁵

Ineffable, intrinsic, private, and immediate, sensations of color can be thought of as *qualia*, or "raw feels"—perceptions in and of themselves.⁶

Qualia, if they exist—not yet unified into "things"—are exclusively mental images that arise in feedback with things through a process of paying attention. As empirically delicate as they are, qualia can be used speculatively to fill the gaps of material experience.

A language game: allowing for the possibility of a sensation such

Opposite: Newton's observation of the spectral colors red, green, and blue refracted from a beam of sunlight—interrupted by a spider dangling in front of the pinhole, its shadow refracting as cyan, magenta, and yellow. . (illustration by CF)

as “reddish-green” gives rise to the mental image of a space of continuous transition between non-adjacent spectral colors.⁷ Once this representation is created, what can be done with it is infinite.⁸

Goethe’s extensive project to understand color, conducted over twenty years and published as “*Zur Farbenlehre*” in 1810, systematically expands on the continuous interaction of color, images, and facts.

Assailing an ambiguity introduced by Newton—an inadequate idea of the nature of seen images—Goethe contended that sunlight passing through a prism is not a “quantity of rays,” as described by Newton, but an image—that all light contains images, and that the formation of an image is a fundamental condition for the visibility of light.⁹

Entering our eyes as something other than pure brightness, “the source of light at work here is bounded, and the sun, in its shining and radiating, has the effect of a form. No matter how small the aperture in the shutter of a *camera obscura*, an image of the entire sun will enter.”¹⁰ What is actually seen is determined by the properties of the image, and by the state of the eye. Objects viewed across an optical interface (through a prism, for example), appear displaced; boundaries transformed into continuous, colorful transitions. The original image of the object is still evident, spread out and overlapping.

Goethe shows color phenomena to be dynamic and in that sense “metamorphic,” associating his color studies with his earlier research of plant morphology and geology, making his own comprehensive project of natural science.¹¹

Sharply criticizing Newton’s presentation of the spectrum as something finished, unchanging and factual;¹² Goethe represents the visible spectrum as an unstable image, one consequence within a continuity of potential outcomes.

By continuously varying the conditions of Newton’s original experiments, Goethe demonstrates a range of alternate outcomes, including Babinet’s principle—that “complementary apertures give rise to complementary images”¹³—where a narrow band of light against a dark background looked red-green-blue through a prism, a narrow band of darkness against a light background looks cyan-magenta-yellow.

Instead of explaining a fixed set of spectral colors by means of a physical model of light, Newton used his image of the spectrum to explain one possible physical model. Inverting the image, i.e. working in a bright room instead of his *camera obscura*, Newton might have arrived at the same physical models, but with different spectral colors.¹⁴

Newton considered the spectral image to be a secondary effect, arising from a set of “primary rays.” Ignoring the bounding of light (i.e.,

the image of the sun produced by a narrow aperture) at the center of his prismatic experiments, Newton, in Goethe’s view, overlooked the highly specified conditions of observation that causes these rays to appear: “Forms are created through a combination of boundary and surface [...] a form must be displaced if colors are to appear.”¹⁵ For a surface with no visible boundaries, variation cannot be perceived:¹⁶

“I was astonished, as I looked at a white wall through the prism, how it stayed white! That only there where it came upon some darkened area, it showed more or less some colour, then at last, around the window bars all the colours shone, whereas in the light grey sky outside there was no colour to be seen. It didn’t take long before I knew that a border was required for color to be brought forth, and I spoke as through an instinct out loud, that the Newtonian teachings were false.”¹⁷

Goethe’s project of reimagining Newton’s color experiments may be understood—by way of historical perspective—as differentiating between two experimental approaches. Newton’s experiments examined (specifically) physical properties of light beams, whereas Goethe’s process was to investigate color from a (generally) physiological, psychological position.¹⁸

Both Goethe and Newton begin with the premise that colors develop in connection with light, and are

thus already contained within it as an idea.

The Newtonian view holds that this *idea* of color is also factually, materially contained in the light, waiting to be unfolded by passing a beam through a refracting prism. Using his own word—“refrangibility”—to point to a quality “intrinsic to light [...] that refraction serves to reveal,” Newton was careful to identify the mechanism of his theory as distinct from refraction, the visible event occurring “when light encounters different transparent media, [...] a property of both light and the media.”¹⁹

For Goethe, ideas and facts are materially separate, and as such belong to different categories. Perceived colors are new formations arising “from an image which now belongs to the eye,”²⁰ not “beings which are merely unfolded out of the light.”²¹

Newton’s *Experimentum Crucis*, with its image of sunlight as composed of a fixed set of primary colors, can be read as unfinished: as colorimetrist Jan Koenderink points out, “Sunlight can be decomposed in an infinite number of (very different) ways, and the spectral decomposition is only one possible instance;” but “no such decomposition is actual unless it is actually performed” (A sausage is not composed of slices before you slice it).²²

Goethe prefaces his color theory with this extended metaphor: “In



reality, any attempt to express the inner nature of a thing is fruitless. What we perceive are effects, and a complete record of these effects ought to encompass this inner nature. We labor in vain to describe a person's character, but when we draw together one's actions, one's deeds, a picture of their character will emerge. Colors are the deeds of light: what it does and what it endures."²³

By means of constant comparison of effects—adjusting, simplifying, and re-complicating the experimental set-up—many apparently isolated facts can be represented as points along the continuous curve of a single dynamic phenomenon, moments that correspond to the varying conditions of a basic experiment.²⁴ Focus shifts away from the practice of attaching hard links between experiment and explanation, towards the work of creating associations between the experiments themselves.

Through a “series of experiments that border on one another closely and touch each other directly” Goethe sought to present “a single piece of empirical evidence explored in its most manifold variations.”²⁵ Preserving the variety and richness of the underlying data, an ideal understanding emerges—similar to that form of translation which Trinh T. Minh-ha refers to as materializing “the multiple oneness of life.”²⁶

Consider this way of creating

meaning—as a presentation of complex interrelation—next to contemporary qualitative research methods:²⁷ Case studies consisting of interviews, questionnaires, and raw empirical data, take into account the reflexive role of the investigator and the influence of context, of circumstance. Interpretation is assembled through a process of recursive abstraction: connecting, annotating, summarizing, allowing criteria for quantitative comparison to emerge gradually from the data itself.

The map-making of qualitative analysis, as compared to the road-building of quantitative or theory-oriented research, works best within complex systems or emerging fields, where the connections between empirical data and underlying principles are unknown or unstable.

Instead of demonstrating underlying principles directly, an exploratory process in which “experiments and concepts co-develop, reinforcing or weakening each other in concert” works to open the full variety and complexity of “situations in which no well-formed conceptual framework for the phe-

Opposite: Newton's observation of the spectral colors red, green, and blue refracted from a beam of sunlight—interrupted by a spider dangling in front of the pinhole, its shadow refracting as cyan, magenta, and yellow. (illustration by Gretta Johnson)

nomena being investigated is yet available.”²⁸

At the time of Goethe’s experiments with color in the late 18th century, no framework existed for the scientific study of color outside of the physics of light. Color phenomena were categorized as consequences or effects of the physical theory—if not dismissed offhand as imaginary or accidental.²⁹

Hoping to resist what he saw as a failure of *a priori* reasoning, Goethe viewed his participation in science as contributing to a mutable process of organization, in which meaning-making would be cumulative and open-ended. Goethe presented his observations in an easy-to-follow didactic format, using readily available materials, so that “everyone will then be free to connect them in [their] own way, to form them into a whole... This approach keeps separate what must be kept separate; it enables us to increase the body of evidence much more quickly and cleanly than the method which forces us to cast aside later experiments like bricks brought to a finished building.”³⁰

Goethe’s “*Contribution to Optics*” (“*Beiträge zur Optik*”, 1791) offers a contrast to the polemics of the later *Zur Farbenlehre*. The tone is easy and generous; a set of woodblock-printed test-cards was bundled with the printed edition, encouraging the reader to try Goethe’s experiments for themselves, even to modify the printed images if so

motivated by curiosity.³¹

“*Contribution to Optics*” takes the form of structured inquiry, exploring the “edge color” (“*Kantenfarben*”) phenomena associated with refraction at light-dark boundaries.³²

First, Goethe asks the observer to view their surroundings through a prism and to notice the variety of colored fringes that appear throughout the scene.

Next, the observer is asked to view a clear sky through the prism, noting that no unusual color effects appear, but when the tiniest cloud comes into view, fringes of color comes into being immediately

Looking at the printed cards, starting with a pattern of “worm-like” black lines. Correspondingly chaotic and somewhat blurred colors cling to the edges of the lines.

The next card, a grid of black and white squares, gives rise to a regular set of colored fringes, an effect that is repeated across each square in the grid.

Cards with black and white stripes or zig-zag shapes show how the fringes (red-yellow, violet-blue) can be dramatically modified by changing the pattern’s orientation with respect to the prism’s refracting edge.

Each new image is simpler than the previous one. The last card in the set is painted half black / half white, with a single straight boundary between the two fields. Viewed with the prism’s refracting edge

pointed downward and parallel to the boundary, by-now-familiar colors appear. Rotating either the card or the prism 90° causes the colored fringe to disappear.

With the black half of the card below the white half, the boundary appears fringed with light blue (cyan) on the white (upper) side, and dark violet on the black (lower) side. Rotating the card 180°, a yellow fringe appears on the white (lower) side of the boundary, and a red fringe appears on the black (upper) side. For Goethe, the appearance of these colors along a form’s boundaries constitutes the essential phenomenon (“*Urphänomen*”) for this set of observations.

A reader of *Zur Farbenlehre*, attempting to locate Goethe’s “theory” of color, might ask what the cataloged multiplicity of observed effects are designed to prove. Goethe’s method—trying each experiment himself, collecting as much empirical evidence as possible, and developing the range of “experiments in their most manifold variations so that they become easy to reproduce and more accessible”—is a prompt rather than a proof. Privileging a continuous presentation of difference over direct explanation, Goethe proposes an experimental process in which “the method itself will fix the bounds to which they must return.”³³

Identifying the way in which observed effects define the limits of an idea, Goethe uses the term “*Ur-*

phänomen” to point to an essential moment or condition that allows the ideal interconnections between perceptions to become self-evident: “From this point on everything gradually falls into place under higher principles and laws which do not reveal themselves to our intellect through words and hypotheses but rather show themselves in equal measure to our intuitive perception through phenomena.”³⁴

Goethe then re-complicates the experiments, systematically varying the experimental conditions (shape, size, color, orientation, and inversions of the images viewed; the refracting angle of the prism; the distance between the images and the prism; the intensity of illumination, etc), determining how each aspect influences what is seen.

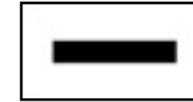
Stepping through continuous variations that he characterized as subjective (placing a prism between his eye the world) or objective (stepping back to watch forms projected onto surfaces), Goethe describes each phenomenon as changing along with its circumstances.



Holding a card with an image of a horizontal white stripe against a black background, moving it away from the prism to change the relative size of the stripe, the red-yellow



and violet-blue edge colors appear to spread out until they meet in the middle of the stripe and white is no longer visible. Where the edge colors meet, green appears: *black, red, yellow, green, blue, violet, black.*



The same action with the image on the card inverted—a black stripe against a white background—extends the edge colors until black is no longer visible. Where the edge colors meet, magenta—non-spectral purple—appears: *white, blue, violet, magenta, red, yellow, white.*³⁵

Goethe's hope was that anyone trying this themselves would see this plainly (the cover of this book shows it too), the appearance of two complementary versions of the visible spectrum: red-green-blue in the first case (as Newton had observed) and cyan-magenta-yellow in the second.

For each observer, both the act of seeing, and the act of putting-together what is being seen, occur in unique ways. Goethe's experimental method is situated in the continuum between these two modes—*“Anschauung,”* or “on-looking,” analytic acts of perception designed to let things speak for themselves; and *“Vorstellungsarten,”* ways of conceiving an ordered representation of things, designed to synthesize, to predict the full gam-

ut of related phenomena.³⁶ Understanding is the oscillation between sense-perception and image-making—a cyclical process of inquiry³⁷ that foregoes abstract explanation, arranging the original material into sensible forms that can be used as analytical tools—“What counts here—first and last—is not so-called knowledge of so-called facts, but vision—seeing. Seeing here implies *Schauen* (as in *Weltanschauung*) and is coupled with fantasy, with imagination.”³⁸

Zur Farbenlehre presents *qualitative data* for a theory of color, rather than a theory *per se*; anticipating the necessity of paradigmatic shifts in science's construction of understanding, Goethe was “...not so much interested in opposing ‘his’ theory to another as in reopening the science of color to new kinds of investigations, recalling researchers’ attention to the phenomenal basis of their theories, and reforming the method and purpose of scientific argumentation”³⁹

In Goethe's scientific studies, “theory” is not a mental abstraction, proposition, or model, but direct contemplation and perceptual recognition. In the sense conveyed

Opposite: Newton's observation of the spectral colors red, green, and blue refracted from a beam of sunlight—interrupted by a spider dangling in front of the pinhole, its shadow refracting as cyan, magenta, and yellow. (illustration by Ron Regé Jr.)

by the Greek *“theoria”*—the activity of the spectator—it is an activity rooted in phenomena:⁴⁰ “Let us not seek for something behind the phenomena—they themselves are the theory.”⁴¹

It follows, then, that no theory of color can be fixed or finished—no spectrum can be complete. Julia Kristeva pinpoints this understanding: “Color is not the black cast of form, an undefilable, forbidden, or simply deformable figure; nor is it the white of dazzling light, a transparent light of meaning cut off from the body, conceptual, instinctually foreclosed. Color does not suppress light but segments it by breaking its undifferentiated unity into spectral multiplicity [...] Color is the shattering of unity.”⁴²

An image of sunlight streams through the window into a darkened room; caught by a prism, a range of spectral colors becomes visible everywhere light touches. Understanding is immediate and intuitive—the varieties of color appear continuous and complete; an image of the spectrum floats across surfaces, a part of light not fully connected with objects.

Now this image appears unexpectedly different—a new sequence, with new colors altogether, fragmented, displaced, without continuity, with boundaries undefined. If the beauty we ascribe to the spectrum is only “the accidental consequence of arranging stimuli in order of wavelength,”⁴³ is a mental

image as beautiful?

Build a model, capturing only the essential conditions to produce an image of the spectrum. Use it to make new images and find—alongside the familiar version—a range of new images, a spectrum of alternatives.

notes

1 Truitt, Anne. *Daybook, the Journal of an Artist*. New York: Pantheon, 1982. 168-169.

2 Sepper, Dennis. “Goethe and the Poetics of Science.” *Janus Head* 8(1). 218. Amherst, NY: Trivium Publications, 2005.

3 Although later incorporated into a wave-particle theory of light, Newton’s theory described light in terms of particles, or “corpuscles” formed into rays: “The rays to speak properly are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour... so colours in the object are nothing but a disposition to reflect this or that sort of rays more copiously than the rest.” (Newton, Isaac. *Opticks*, Book 1, Part 2, Prop. 2 (London, 1704).

4 Koenderink, Jan J. *Color for the Sciences*. Cambridge, MA: MIT, 2010. 213.

5 Benjamin, Walter. “A Child’s View of Color”. Transl. Rodney Livingstone in *Benjamin: Selected Writings, vol. 1: 1913-1926*. Cambridge MA: The Belknap Press of Harvard University Press, 1996

6 Dennett, Daniel C. “Quining Qualia.” *Consciousness in Contemporary Science* (1992): 42-77.

7 Wittgenstein, Ludwig and Transl. G. E. M. Anscombe. *Remarks on Colour*. Berkeley: U of California, 1977. §11.

8 Ramachandran, V.S. and Hubbard, E.M. “Synaesthesia — a window into perception, thought and language.” *Journal of Consciousness Studies* 8, 3-34. (2001).

9 Sepper, Dennis. *Goethe contra Newton: Polemics and the Project for a New Science of Color*. New York: Cambridge University Press, 1988. 147-148.

10 Goethe, J.W. *Zur Farbenlehre* 1810a. Transl. Miller, Douglas. as "Theory of Colours". in *Scientific Studies*. New York, NY: Suhrkamp, 1988. §309

11 Seamon, David and Zajonc, Arthur, (Eds.) *Goethe's Way of Science: A Phenomenology of Nature*. Albany, NY : State University of New York Press, 1998. 43.

12 Goethe 1810a, §217

13 ...or "the image of the negative of an object is the negative of the image of that object." (Koenderink 2010, 217; 228)

14 Holtmark, Torger. "Newton's Experimentum Crucis Reconsidered" *American Journal of Physics*, Volume 38 Number 10, October 1970.

15 Goethe 1810a, §198

16 Goethe 1810a, §191

17 Goethe, J.W. "Confessions of the Author." 1810b. Transl. Herb Aach, in Mathhaei, Rupprecht. *Goethe's Color Theory*. New York: Van Nostrand Reinhold, 1971

18 Sepper 1988, 8

19 In opposition to the prevailing "modificationist" view that colors arise once light is changed by the prism, Newton hoped to demonstrate that colors are intrinsic material properties of light. (Sepper 1998, 124)

20 Goethe 1810a, §49

21 An allusion to the theory of "preformationism," in which organisms develop from miniature versions of themselves. (Steiner, Rudolf. *Goethe's World View*. 1897.)

22 Whether we consider it as pure (as Goethe did) or as a confused mixture (as Newton did), "Sunlight" is due to numerous events, each of short duration, happening at random intervals. Their superimposition is a stochastic process of which the 'original parts' are pulse-like phenomena rather than monochrome waves of infinite duration." (Koenderink 2010, 75; 230)

23 Goethe 1810a, preface

24 Sepper 1988, 69-70

25 Goethe, J.W. "The Experiment As Mediator between Object and Subject." 1792. Transl. Douglas Miller, in *Scientific Studies*. New York, NY: Suhrkamp, 1988.

26 In discussing the use of color-correction in documentary filmmaking. (Minh-ha, Trinh T. *Framer Framed: Film Scripts and Interviews*. London: Routledge, 1992. 120.)

27 Denzin, Norman K. & Lincoln, Yvonna S. (Eds.). (2005). *The Sage Handbook of Qualita-*

tive Research (3rd ed.). Thousand Oaks, CA: Sage.

28 Ribe, Neil, and Friedrich Steinle. "Exploratory Experimentation: Goethe, Land, and Color Theory." *Physics Today* 55.7 (2002): 43-49.

29 Sepper 1988, 31

30 Goethe 1792

31 Goethe, J.W. "Contributions to Optics" 1791, §62. Transl. Herb Aach, in Mathhaei, Rupprecht. *Goethe's Color Theory*. New York: Van Nostrand Reinhold, 1971.

32 These phenomena were categorized by Goethe as "Dioptic Colors", color effects arising from the interaction between light and a colorless medium, e.g. a prism. (Goethe 1810a, §9)

33 Goethe 1792

34 Goethe 1810a, §175

35 "Magenta" wasn't used as a color name until 1859. Goethe called it "peach blossom." This color can also be called "fuchsia" (named for the flower) or "red-purple"—as a non-spectral color, it presents a special case for color models. (Goethe 1791, §59)

36 Sepper 2005, 221

37 compare to John Dewey's definition of inquiry as the "transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (Dewey, John. *Logic, the Theory of Inquiry*. New York: H. Holt, 1938. 104.)

38 Albers, Joseph. *Interaction of Color*. New Haven: Yale University Press in Association with The Josef and Anni Albers Foundation, 2009.

39 Sepper 1988, 16

40 Seamon and Zajonc 1998, 171

41 Goethe, J.W. "Maxims and Reflections". Transl. Douglas Miller, in *Scientific Studies*. New York, NY: Suhrkamp, 1988. 307.

42 Kristeva, Julia. "Desire in Language." Berkeley and Los Angeles, CA: University of California press, 1980.

43 Land, Edwin H. "Experiments in Color Vision." *Scientific American* 200.5 84-96. (1959):

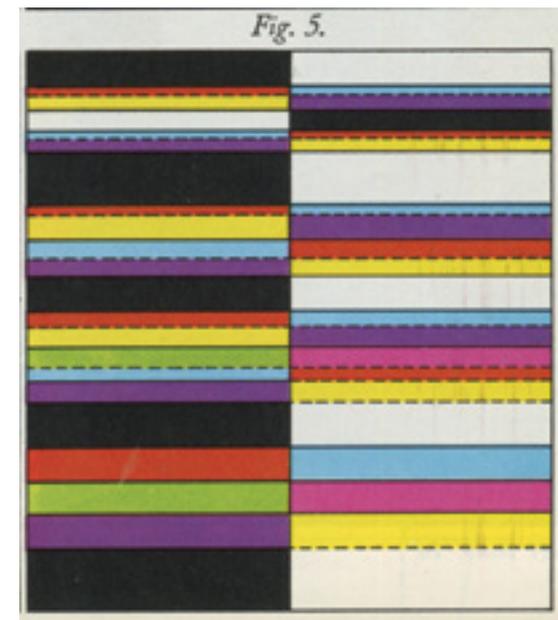
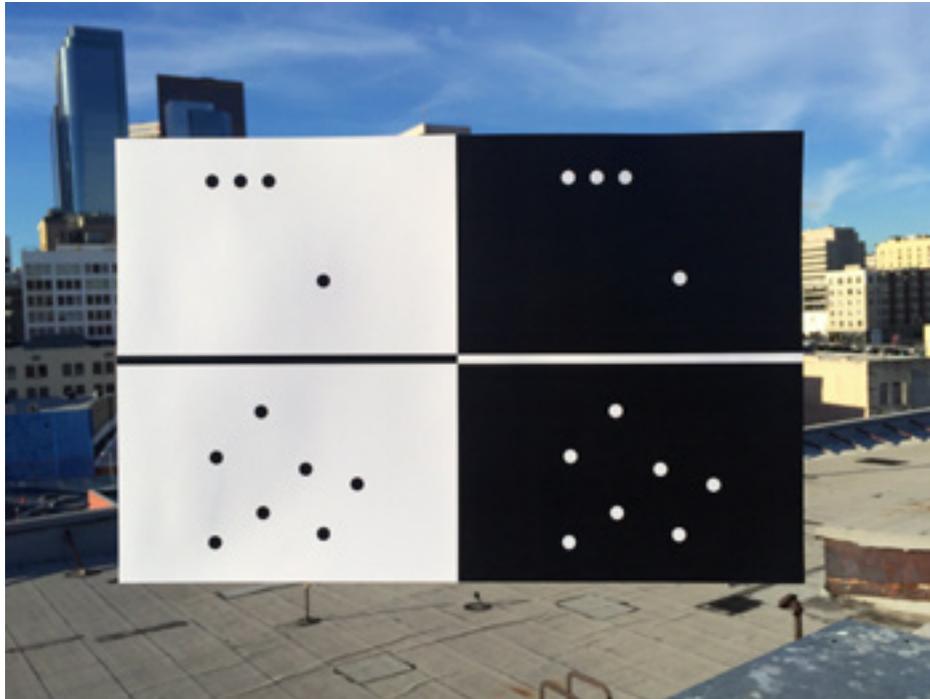
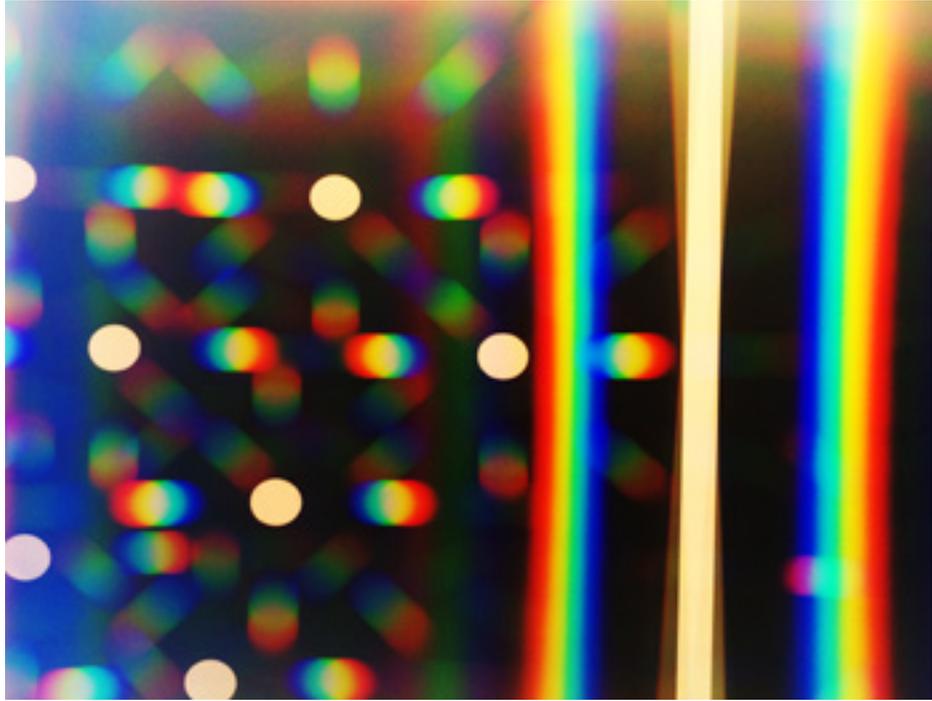
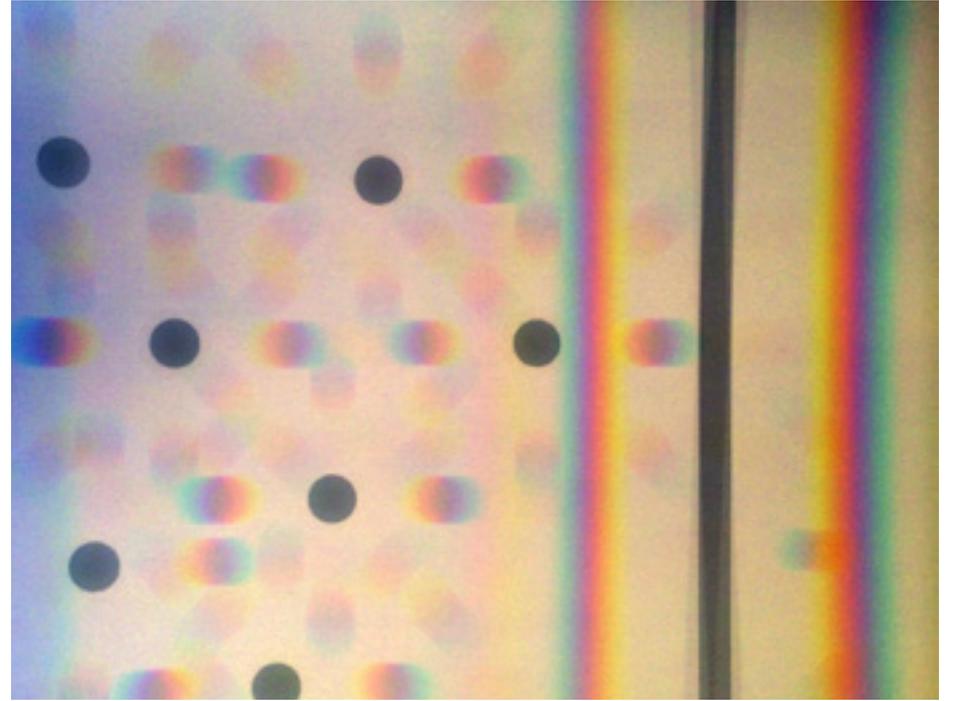
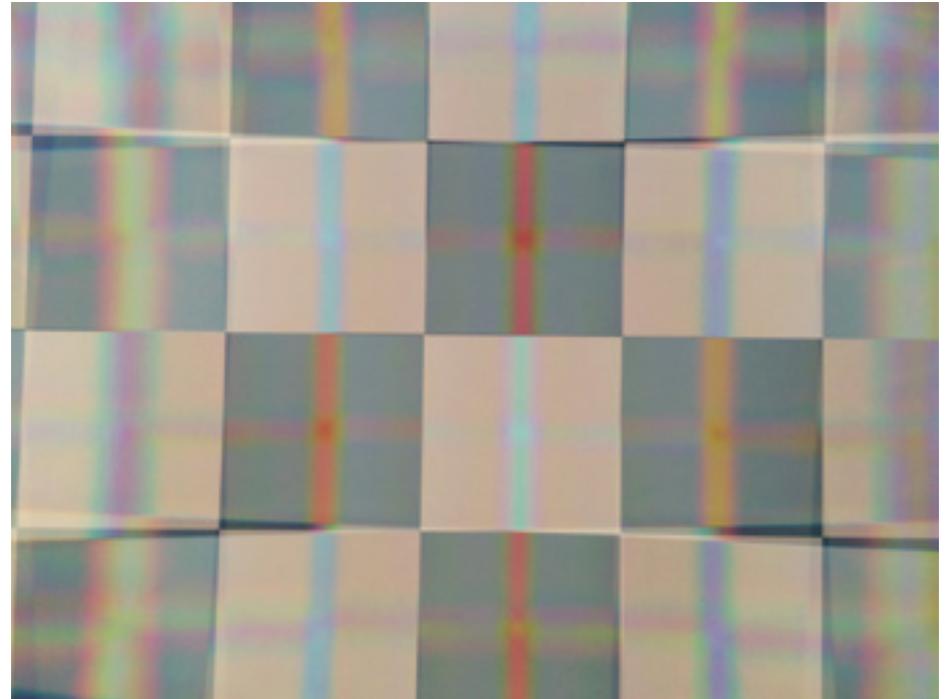
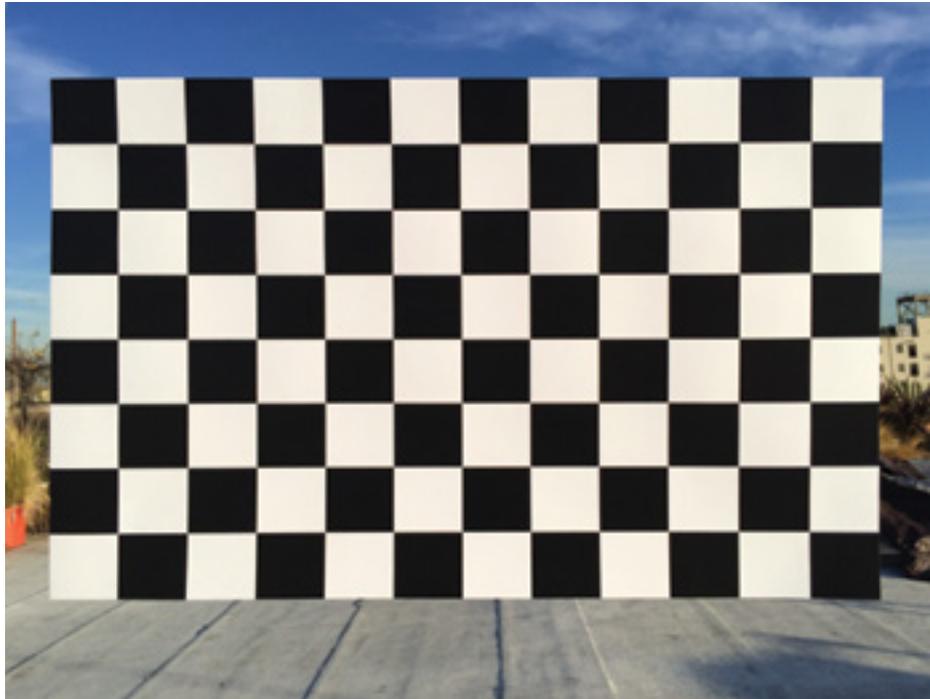
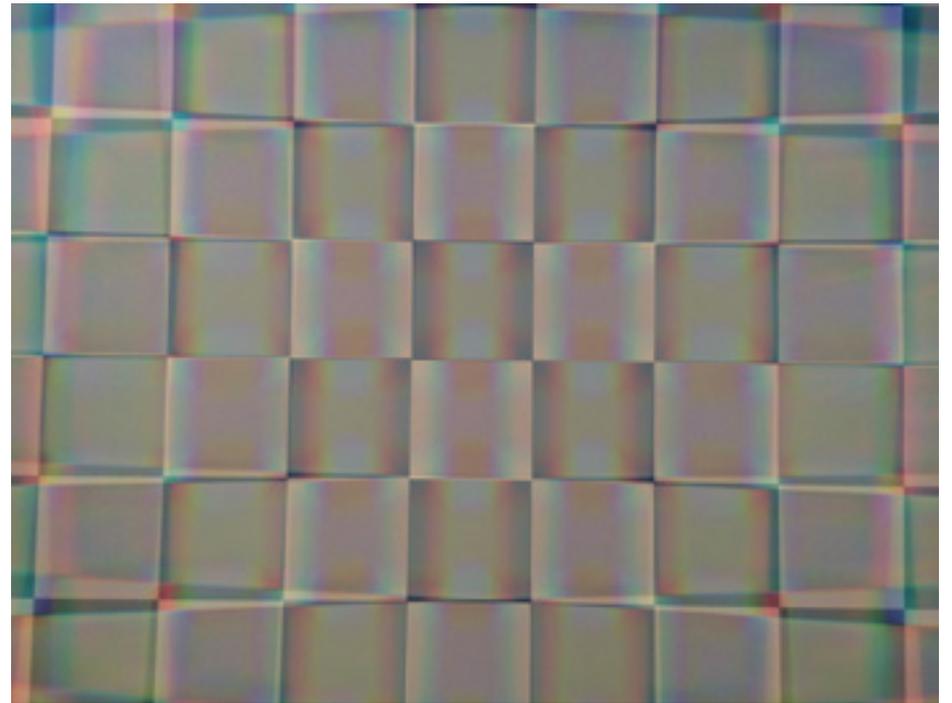


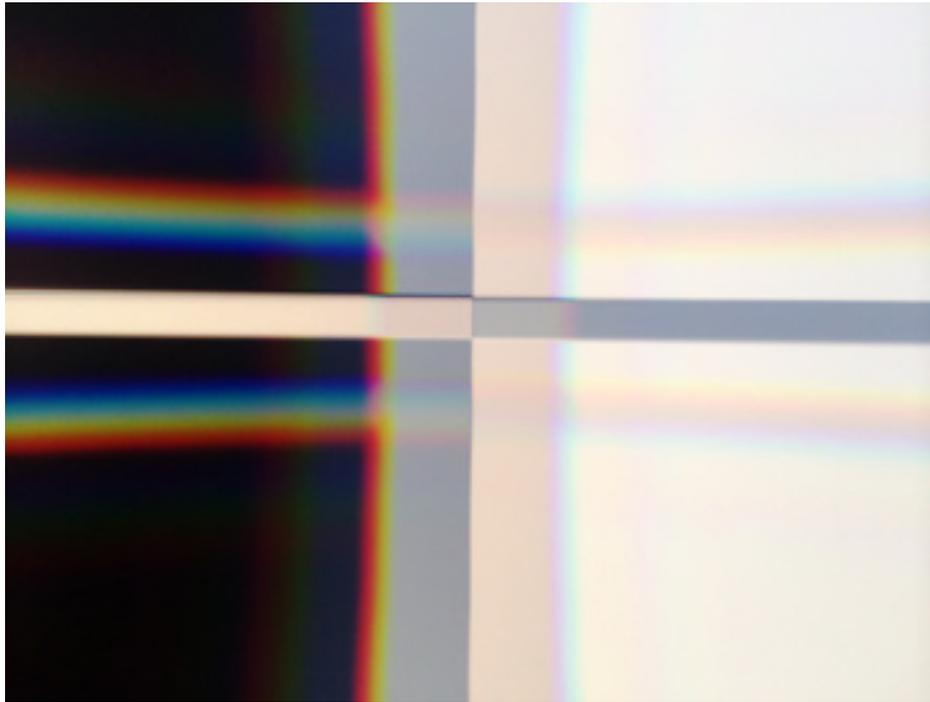
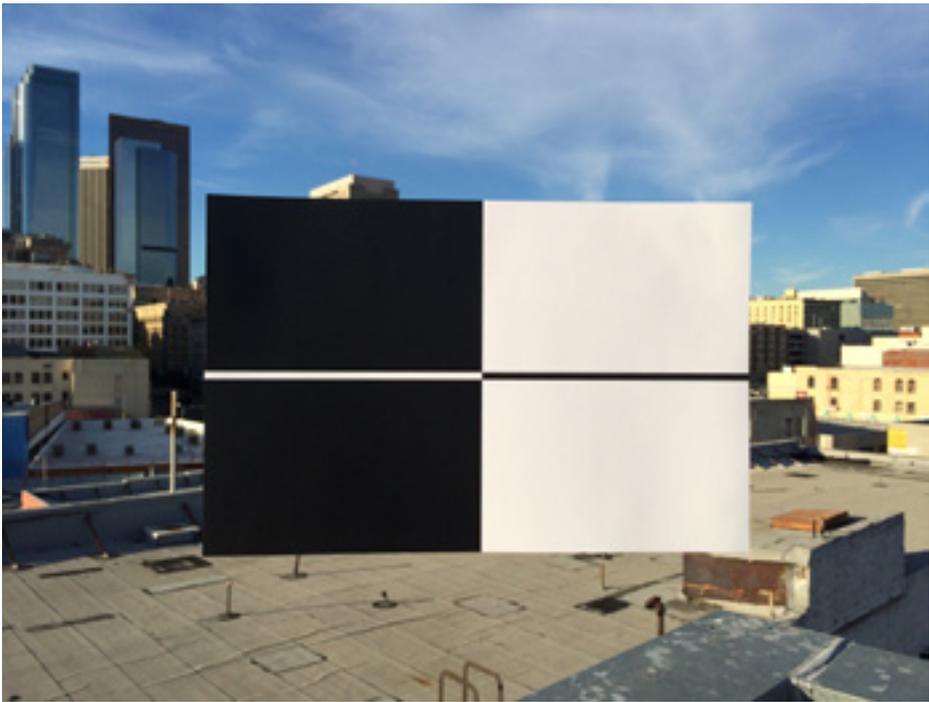
Illustration from J. W. Goethe's "Zur Farbenlehre" (1810) comparing edge-color effects. A band of light against a dark background (left), viewed through a prism at different distances, gives rise to color fringes along the boundaries, overlapping and interacting to produce a red-green-blue spectrum. A band of dark against a light background (right), under otherwise identical circumstances, produces the inverse image: a cyan-magenta-yellow spectrum.

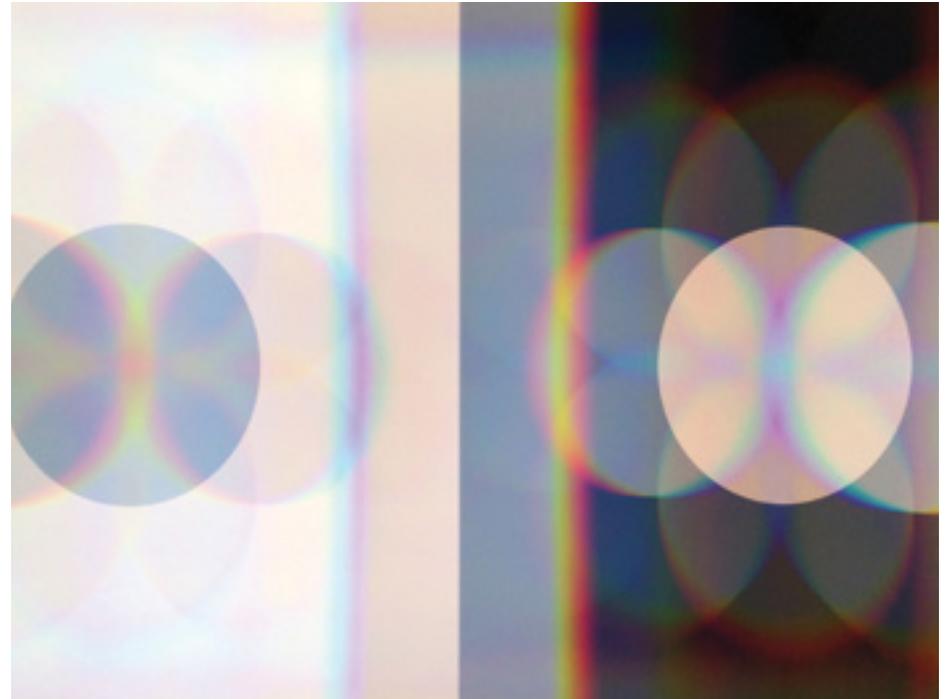
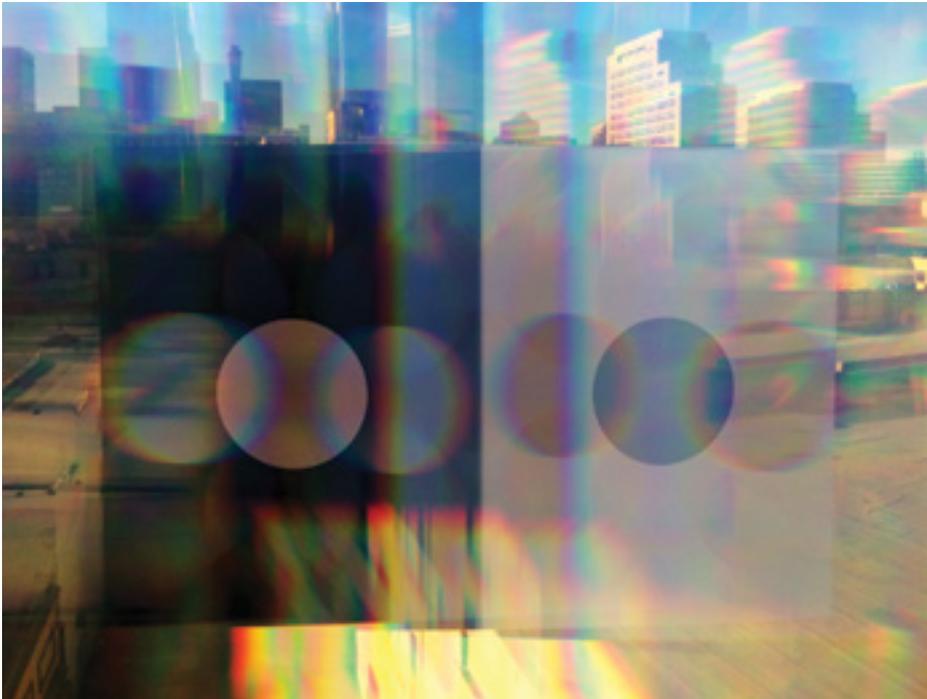
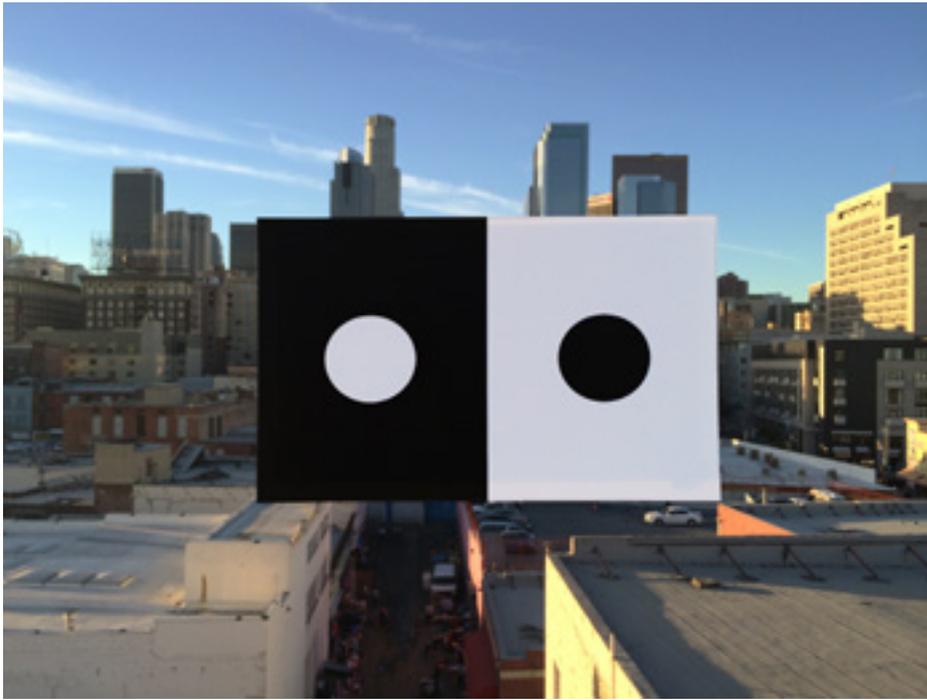
















Monochromator

Sarah Rara

what is seen
when one looks
through prism
at white fig
on black ground

central portion remains white

what is seen
when one looks
through prism
at black fig
on white ground

central portion dissolves into color

green and peach blossom
dominating dissolving component

color radiation at the edges
light ray split by a hole in the shutter

dark ray split in seven colors
heading for a great confusion

stars in the sky
holes in the lamp shade

let me proclaim the colors in my own way

monochromator

identity operator
spectral basis complete

photon detective
electro event

casual and causal
lost all clues

unknown photon energy
of the absorbed

phenomenon of color
physiological as thought

feeling without seeing

trouble with subjective and objective
fused together

blinding after-images
similar to color phenomena

unique eye events
looking at the sun

don't search beyond phenomenon
it is the precept goethe

colors of shadows
trusting the eye

eye-world

seeing by wavelength
monochromatic image

spectrum linear series
superimpose musical scale

light composed of slices
only when sliced

decomposition not actual
until actually performed

unique fundamental
spectrum every color

color appearances
difficult speak

radiation striking retina
difficult sense

red as experience as
indefinable as color

monochromatic beams
non-entities
realized approximately
only

defining subspace
projection operator
color of beam

color space
three dim vector space

physical beam
linear space
infinite dim

spectral basis
awkward

splitting a beam
two components
light dark beam

linear space
has no atomic
part
s

volume of air
storm veil

sun cone cuts the veil
experiences arranged in sequences

light color time subject
condition of space where no object is perceived

surfaces of objects actively visible
separating black and white from color

light on drops of water
against dark

peach blossom purpur
fast wavelengths

running against the eye
looking at the uncolored candle

beveled window edge
slices color

sun hastening light
darkness in stillness
two-stepped vast
border spectra

red leans
yellow or blue
wormlike lines
blurred emission

suspension bent
vaulted stripe
color sequence
of a white stripe

violet will radiate
black will dissolve
green will dominate

black on white
gray on black
white on gray

blue contour
seen through
blue tinted lens

right eye
to-it-belonging
contour

white object
scattering all radiation

hue-less lines
through color space

shadow-like entities
necessarily incomplete

yellow as daylight
missing blue

non-overlapping
and abutting beams

two vertices achromatic
bounding luminous experience

color experience
curves an arc

scattering all light
except one part

full color
semi-chromes

limiting wavelengths
complementary

newtonian spectrum
beautiful accidental
consequence of arranging
stimuli in wavelength order

look-through prism
expectation color
white wall remains white
disappointment visually oriented
marvel at color occurrences
uncover something not undercover

boldly goethe
my color theory
is as old as
the world
herself

her color world
experiment as transmitter
object to subject
irrational empiricism

eye more wonderful than previously
thought building worlds in colored
materials fanned into bands of colors
we now know as the visible spectrum
process recombining into white

remaining diagrams
infinity by guess

side-stepped limitations
pleasure reveals pleasure

enemies on the shore
knowledge a body of water

running counter to fact
ship with wrong sail

isolated ideas
floating proposition

border and contact
effects we can perceive

sunny eye
made for light

chromatic harmony
difference opinion

region of phantoms
retina upon light

backward glance
economy of nature

alternate impressions
blindingly colorless

laws of vision
yellow demands purple

dark object
appears smaller

leading colors
called harmony

color appearances
made in the snow
climbing Mt Brocken
on Dec 10, 1777

fleeting mistakes in seeing
now the norm and guideline
all residual visible evidence
in transit

radiant into thermal
energy transfer

mono
energetic
photon

mono
chromatic
event

photon
number
flux

kicking an electron
into another state

photoreceptor
human eye mine

translating photon event
into electro chemical events

actual photon energy
lost in translation

sensitive eye
radiant flux

black on the left
white on the right
orange on the left
blue on the right
yellow on the left
violet on the right

warm

white on the left
black on the right
blue on the left
orange on the right
violet on the left
yellow on the right

cool

green on the way to black
red on the way to white

magenta returns

cardinal colors
beads on a necklace

the rest fall in place
internal symmetry

bisect your neighbor
bright white center

helmholtz found
no partner for green

green as furthest from
gap of purples

green-failing to find
the other part of white

green mystery
without counterpoint

blue different
for humans
overlapping least
with other primaries

red not a stable idea

spectrum hinged
butterfly wing space
a different image
of images on earth

unstable partial
noisy multi-dimensional
electro-chemical
translations

the model
aided understanding
but diverted attention
from the actual

seeing

sun on wire
exhibits no color

mirrored sun
iridescent hairlike fissure

scratched by a diamond
bottle will burst

oblique light
casting black cross

inner-linking image
shell-like non-intrinsic

seed in darkness
fruit's juicy capsule

subjective corona
nimbus luminous

white saucer
carmine passing

semi-transparent
transparent emitting

transient not arrested
appearance effects

escape the sun
exit life you want to

flashing from a surface
passing through transparency

passing across an edge
coloring colorless surface

green array pleasure in color
presses eye without structure

broad uniform masses
effects of visible realm

drama of forest
solar reflections

spreading atmosphere
brilliance nearest shadows

objects that make a world
advent volatile image

black body
radiating at the temp
of the sun

range of radiance
active over decades

400 events
per integration time
per receptor

arrival of energy
counting photons
quantum catching

cone receiver
come in

two tangents
spanning a plane
the eye cannot traverse

plane of purples
made of mixtures
monochromatic beams

very long very short
wavelengths interacting
coincidence of opposites

infrared limit
ultraviolet limit
tending red
tending blue

find the point
in non-metric space
furthest away
from plane of purples

if it exists at all
find new deformations
with new primaries

cone with black point apex
purple closing gap
in spectral part

the purple sector
not spectral
mixtures from the edges

200 wavelengths in hair's width
wavy wavy hair

division sphere
vertically oriented

each sphere filled with rays
intensity to zero at the edges

parallel line between orange and green
sphere that transmits yellow

bundling of rays
three-color-process

threefold interrelationship
among six spectrograms

co-dimension three
black space infinitely dim

color hyperspaces
parallel to black

un-cartesian jungle gyms
spectral representation

matching matrix

RGB crate
sitting inside
a spectral cone
of daylight

color atlas
color sphere
light sense

brightness of pure color
indefinable apart from achromatic

purely chromatic sensations
without intrinsic brightness or darkness

color as primate tool
banded biotope
survival on earth

conical space
air cinema
film vibrates air
light as entertainment

electric and magnetic disturbance
unbalance of color
chroma rudeness

relationship to gray
against the clouded

ray mixing
long and short
waving
in a scene

issue of fact itself
what makes fact
looking for

sunlit world experiment

color words
stability limit

brightness control
white flag

fulcrum in ordinary
white light in other

wavelength and color
independent of each other

long-short relationship
short-record stimulus

ratio of intensities
radiant power

radio y x-ray
passing thru
u toujours

radiant patches
proto-image
very significant
to life on earth

mental prior to physical
or physical prior to mental
you choose
again

radiant power spectra
non-negativity
arbitrary order everywhere
on / off

bare information
shaking your receptor

seeing without feeling

“Wrong Spectrum”

is a book by lucky dragons
(Luke Fischbeck and Sarah Rara)

Illustrations

<u>Outside Cover:</u>	Complementary color images generated by complementary apertures: a white slit against a black background gives rise to red, green, and blue (Newtonian, or spectral colors); a black (anti-)slit against a white background gives rise to cyan, magenta, yellow (Goethean, or non-spectral colors).
<u>Inside Front Cover:</u>	Diagram III from the “Didactic Part” of Goethe’s <i>Zur Farbenlehre</i> , for viewing colored shapes through a prism.
<u>Inside Back Cover:</u>	Painted screen design used by Goethe in prismatic experiments, later adapted as a set of printed cards distributed with the text <i>“Contribution to Optics”</i> (1791).
<u>First and Last Pages:</u>	Two example designs from Goethe’s set of printed test-cards depicting a “wormlike” pattern for observing edge color effects.
<u>Pages 33—48:</u>	Reproductions of Goethe’s test cards photographed in a natural setting under various conditions, making use of holographic diffraction grating (13,500 lines/inch, double axis) to evoke edge color phenomena.

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