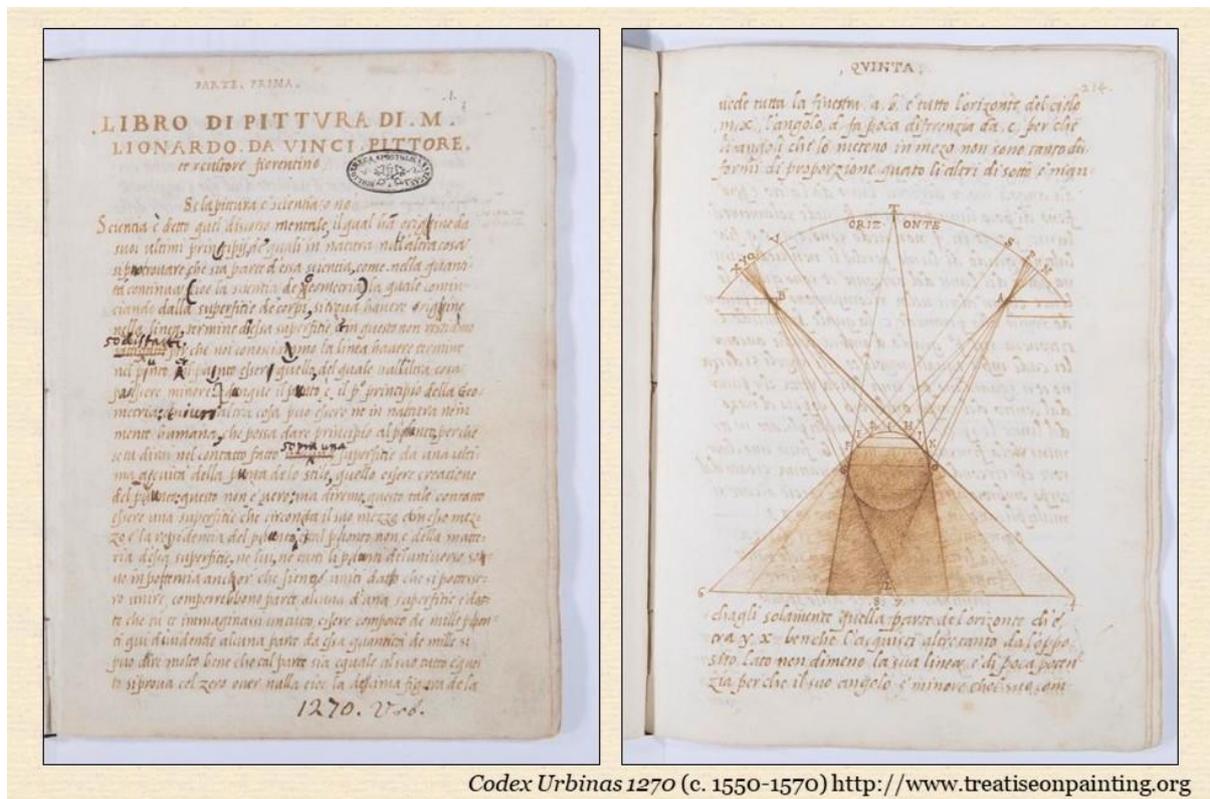


Leonardo da Vinci on Colour, Light and Vision

Selections from the presentation *Leonardo da Vinci on Colour, Light and Vision* by David Briggs for the CSA NSW Division, Albion Centre, Surry Hills, May 29th, 2019.

This year marks the 500th anniversary of the death of Leonardo da Vinci on May 6th, 1519. Leonardo's writings on colour, light and vision have received considerable scholarly attention over the last few decades, some of which has tended to emphasize his debt to and misunderstandings of medieval sources, and thus to diminish his contribution to the progress of science. Nevertheless, Leonardo's copious notes on specular and diffuse reflection, shading and shadows, coloured illumination, atmospheric perspective and other visual phenomena, and of the appearance of specific subjects such as figures, trees, water and mountains, remain relevant for many artists and illustrators as foundation documents in the applied science of depicting visual appearance.



Codex Urbinas 1270 (c. 1550-1570) <http://www.treatiseonpainting.org>

Leonardo's ideas about colour, light and vision are known to us from his remaining notebooks, less than half of which survive today, and from the *Treatise on Painting* compiled from both surviving and now lost notebooks by his heir Francesco Melzi. Melzi's handwritten manuscript of the treatise (the *Codex Urbinas 1270*, above) was lost until the nineteenth century and although it has now been published in English editions (including McMahon, 1956), Leonardo's treatise today is still known to most from translations of various early printed editions that were all based on selectively abridged copies of the treatise.

Considering their great bulk, Leonardo's surviving writings say relatively little about the science of colour itself, but a major innovation claimed for him by the art historian James Ackermann is that he seems to have been the first writer to distinguish between brightness and lightness (*chiarezza*) on the one hand and chroma and colourfulness (*bellezza*) on the other, thus (with hue) implicitly arriving at a three-dimensional conception of colour.

A. Aristotle, c. 330 BC
 λευκῶν ξανθῶν φουρικῶν ἀλουργόν πράσιον κυανῶν μέλαν

B. Chalcidius, c. 325 AD
 candidus pallidus rubeus cyaneus nigredo

C. Bartholomaeus Anglicus, 14th c.
 albus glaucus puniceus, id est citrinus rubeus purpureus viride niger

D. Leonardo da Vinci, c. 1500
 bianco giallo verde azzurro rosso nero

<http://www.huevaluechroma.com/071.php>

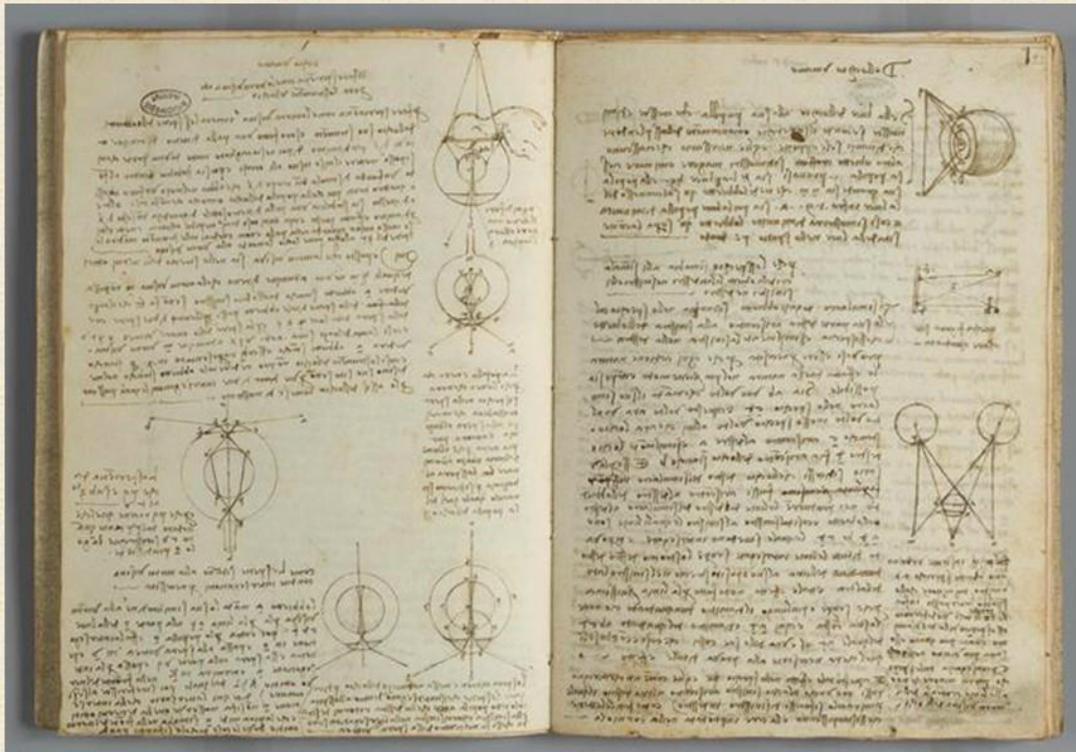
Filarete's *A Treatise on Architecture* (c. 1460) has the same six simple colours as Leonardo.

Of the colors that result from the mixture of other colors, which are called secondary. The simple colors are six, of which the first is white, although some philosophers do not accept white or black in the number of colors, because one is the origin of all colors and the other is their absence. But as painters cannot do without them, we include them in the number of the others, and say that in this order white is the first among the simple, and yellow is the second, green is third, blue is fourth, red is fifth, and black is sixth.
 Codex Urbinas, 75v, 76 (McMahon 176)

Of colors. Blue and green are not in themselves simple colors, because blue is composed of light and darkness, as in the case of air; that is, it is composed of the most perfect black and the purest white. Green is composed of a simple and a compound color, that is, it is composed of blue and yellow.
 Codex Urbinas, 76-76v (McMahon 177)

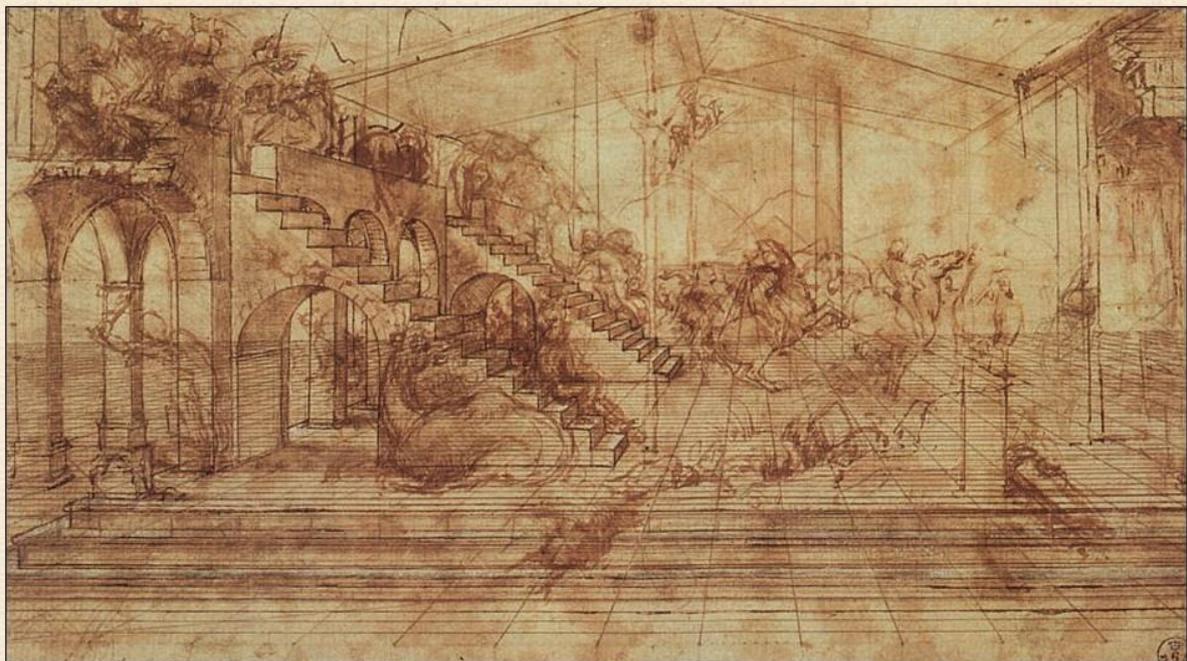
Leonardo is also sometimes credited with initiating the modern concept of four *unique hues*, red, yellow, green and blue, as he lists these four along with white and black as the six "simple colours", but an earlier treatise on architecture from 1460 by Filarete also gives the same six simple colours (Ackerman, 1980, p. 35). In any case Leonardo's text immediately dismisses blue and green as simple colours based on his experience of apparent colour mixing in the atmosphere and in paints respectively, so he may simply have been presenting the six simple colours as the currently accepted wisdom. He does however seem to have been the first to write of red - green and yellow – blue as direct contrasts (McMahon, 180).

Leonardo had no idea of the function of the lens of the eye to focus an (inverted) image on the surface of the retina. He believed the lens to be a spherical body located in the middle of the eye that served to reverse the inversion of the image caused by the action of the pupil as in a pinhole camera, as shown in these pages from his small notebook on the workings of the eye, Paris *Manuscript D*.



<https://www.photo.rmn.fr>

Of far greater importance are Leonardo's extensive observations of all aspects of visual appearance. Although sometimes dismissed as a tragic obsession, these were in fact vital to his aim to depict scenes convincingly in relief in an era when compositions were typically visualized and compiled, not painted from life.



Perspective study for the background of *The Adoration of the Magi*.



Leonardo da Vinci, *Virgin of the Rocks* (London, 1495-1508), detail

The primary purpose of the painter is to make a plane surface look like a body in relief detached from the plane, and he who in that art most surpasses others deserves most praise, and this particular investigation, which is the crown of the science of painting, originates in the shadows and lights or, if you wish, brightness and darkness. Therefore whoever avoids shadows avoids what is the glory of the art for noble minds, but gains glory with the ignorant public, who want nothing in painting but intensity (bellezza) of color, altogether forgetting the beauty and marvel of depicting a relief on what in reality is a plane surface.

Codex Urbinas, 133v (McMahon 434)



Fra Angelico, *The Adoration of the Magi*, detail (c. 1450), detail

Leonardo recognized that the dominant style of colouring of his time, which has been called Cennini modelling, inevitably failed to evoke a realistic visual appearance. In basic Cennini modelling pure pigment is used in the shadows and more and more white is added moving into the lights. While this results in a brightly colourful painting, Leonardo recognized that the visual appearance of objects normally becomes **more** colourful moving from the shadows to the lights.



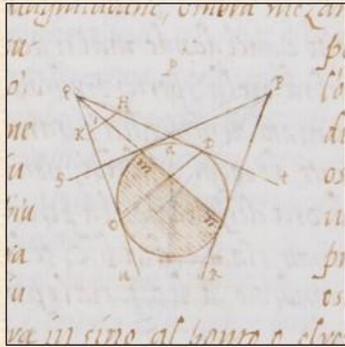
La Belle Ferronnière, detail

Of colors. Colors placed in shadow will partake more or less of their natural "beauty" (intensity) depending on whether they are in greater or lesser obscurity. But if the colors are located in luminous space, then they will look "more beautiful" (more intense), the greater the brilliance of the source of light.

THE ADVERSARY: *The differences of colors in shadow are as numerous as are the differences of color in the things shadowed.*

REPLY: *Colors placed in shadow will differ less and less as the shadows in which they are situated grow deeper. For this there is the testimony of those who from the squares look inside the doors of shadowed temples, where the paintings covered with different colours all appear enveloped in obscurity.*

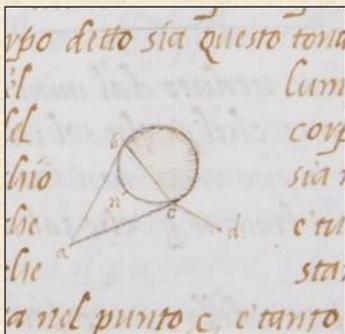
Codex Urbinas, 73v-74r (McMahon 193).



Codex Urbinas, 199r,

What difference there is between luster and light. The difference between luster and light is that luster is always more powerful than light. And light is of greater extent than luster. Luster moves with the eye, or with its cause, or both, but light is fixed in a definite place, if the cause that creates it does not move.

Codex Urbinas, 227 (McMahon 774)

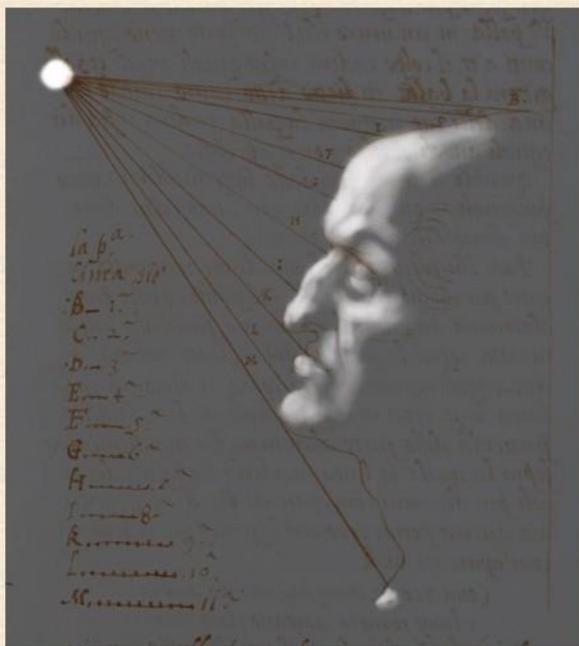


Codex Urbinas, 220r,

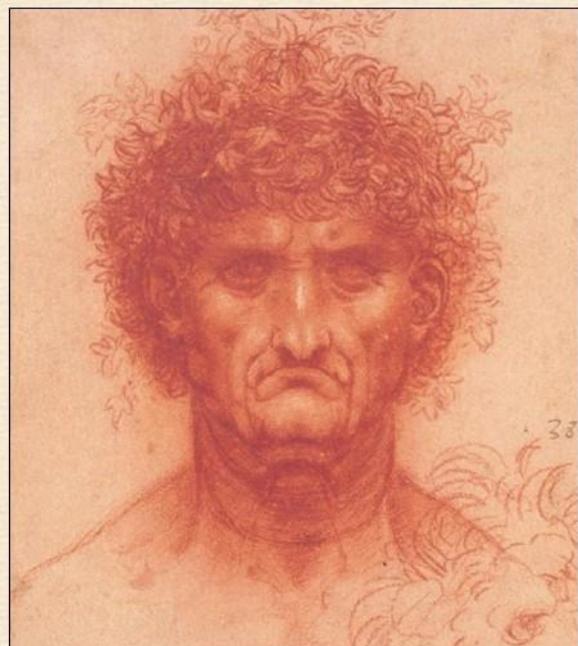
Let us suppose that the body is this round one figured here in the center, and that the light is the point a, and that the illuminated side of the body is bc, and the eye is at point d. I say that when the eye is at point d, the luster, because it is entirely on that side, will appear at the point c, and to the degree that the eye changes from d to a, the luster will change from c to n.

Codex Urbinas, 220 (McMahon 779)

As shown above, Leonardo (like Alberti before him) clearly distinguished between what are now called *specular reflection* (“luster”) and *diffuse reflection* (“light”). This distinction was well understood in antiquity but was lost in the middle ages and then rediscovered by early Renaissance painters. Leonardo’s detailed observations of luster and light on various objects go well beyond the brief observations by Alberti.

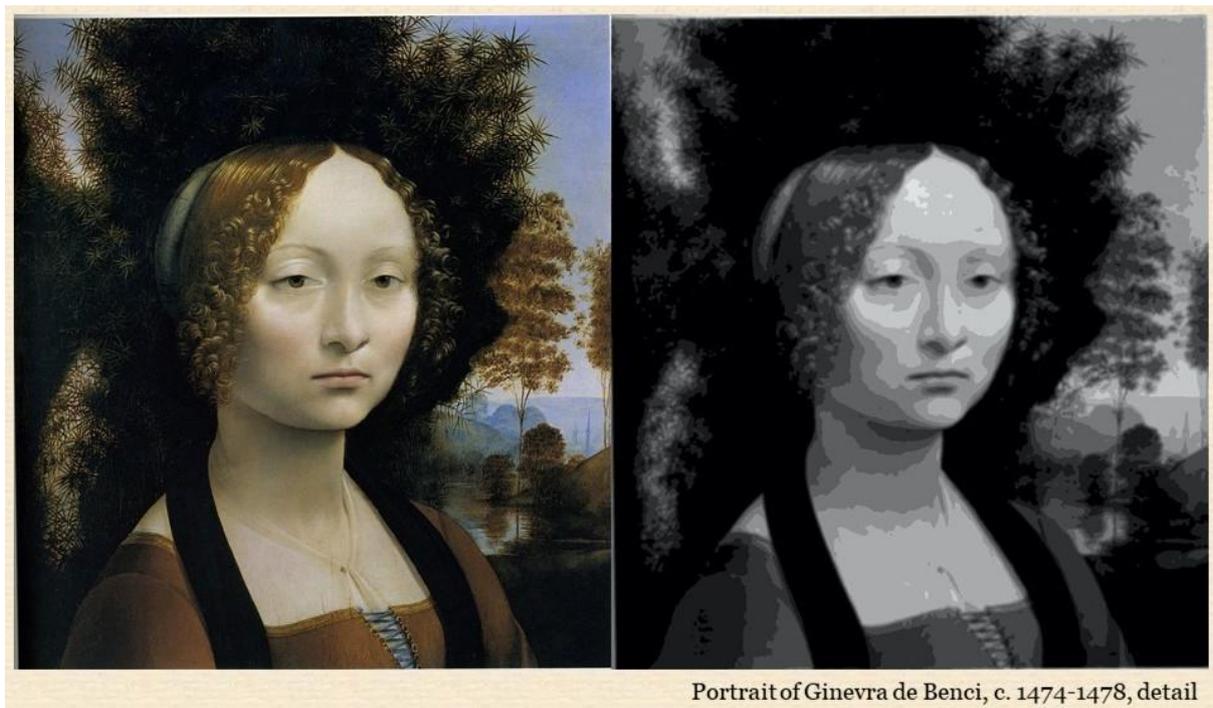
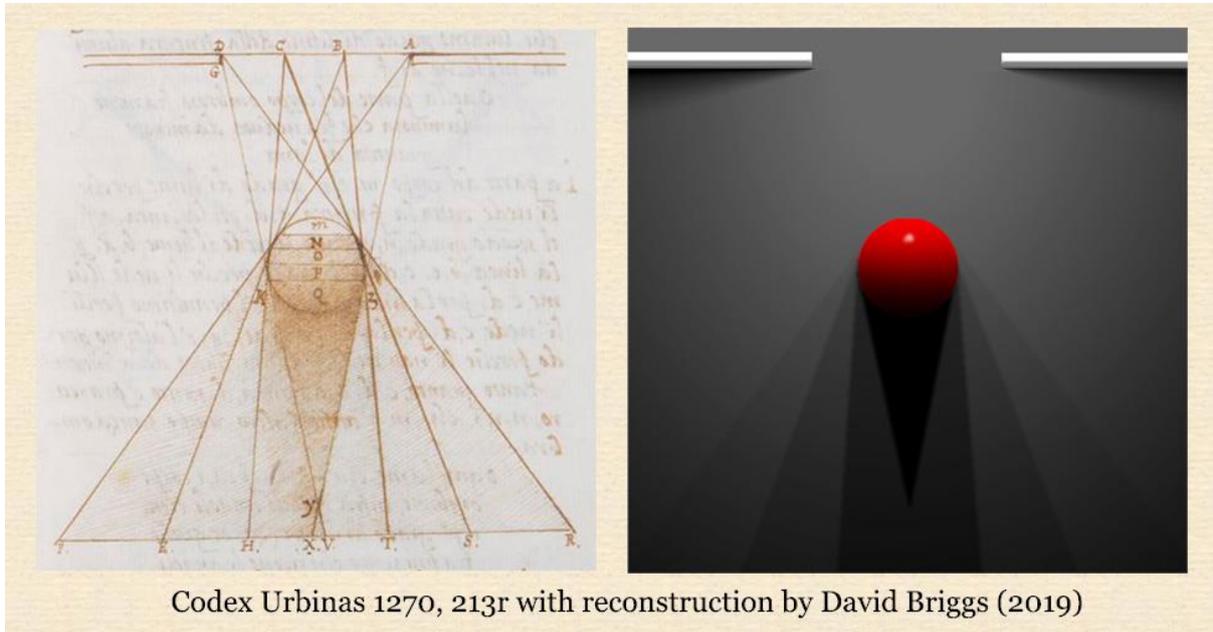


Codex Urbinas, 219r



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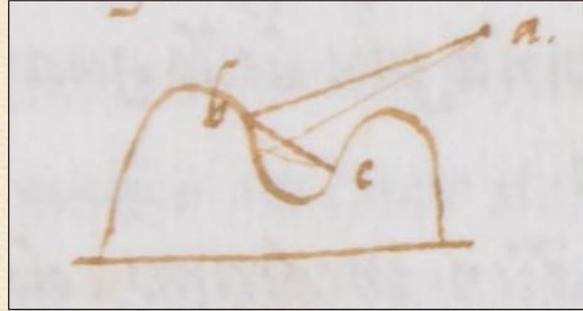
Leonardo made extensive observations of the way that the fall of light modelled the form of objects and on the geometry of cast shadows. To take just one example, this illustration from the treatise investigates the arrangement of shading and cast shadows created when a sphere is illuminated by light entering through a restricted aperture. This clear understanding of the fall of light found a direct application in his painting practice, which is distinguished not merely by the smoothness evident to the non-painter, but by the extremely precise and accurate distribution of values.



One observation that Leonardo made particularly beautiful use of in his paintings was that colours become more saturated (“more beautiful”) when light is reflected by an object multiple times (below).



La Belle Ferronnière, detail



Codex Urbinas, 67v

What part of a color ought, according to reason, be the most beautiful? Let a be the light and b illuminated in a straight line by the light, and c which does not face that light, but only the illuminated part, which, we may say is red. Under such conditions, the light which springs from that side will resemble its source, and will tinge the face c red. If c itself is also red, you will also see that it is much more beautiful than b. If c is yellow, you will see created a colour intermediate between red and yellow.

Codex Urbinas, 67v (McMahon 199)

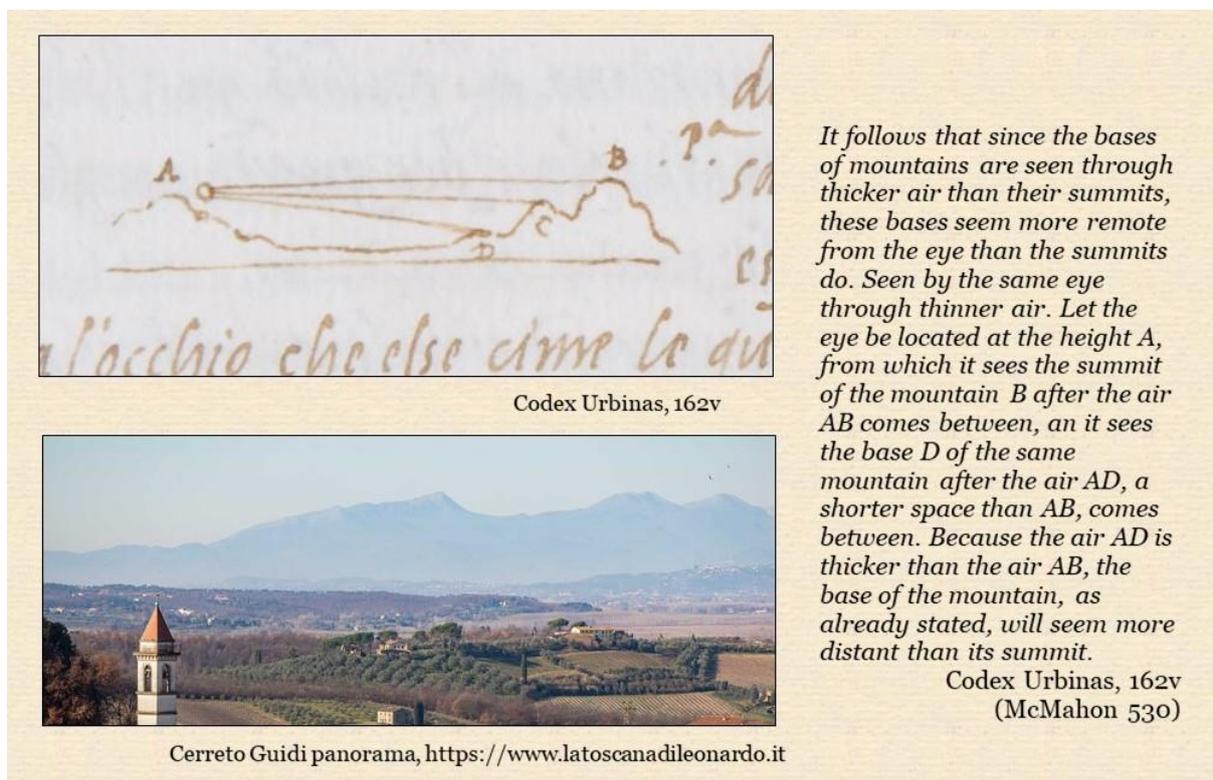
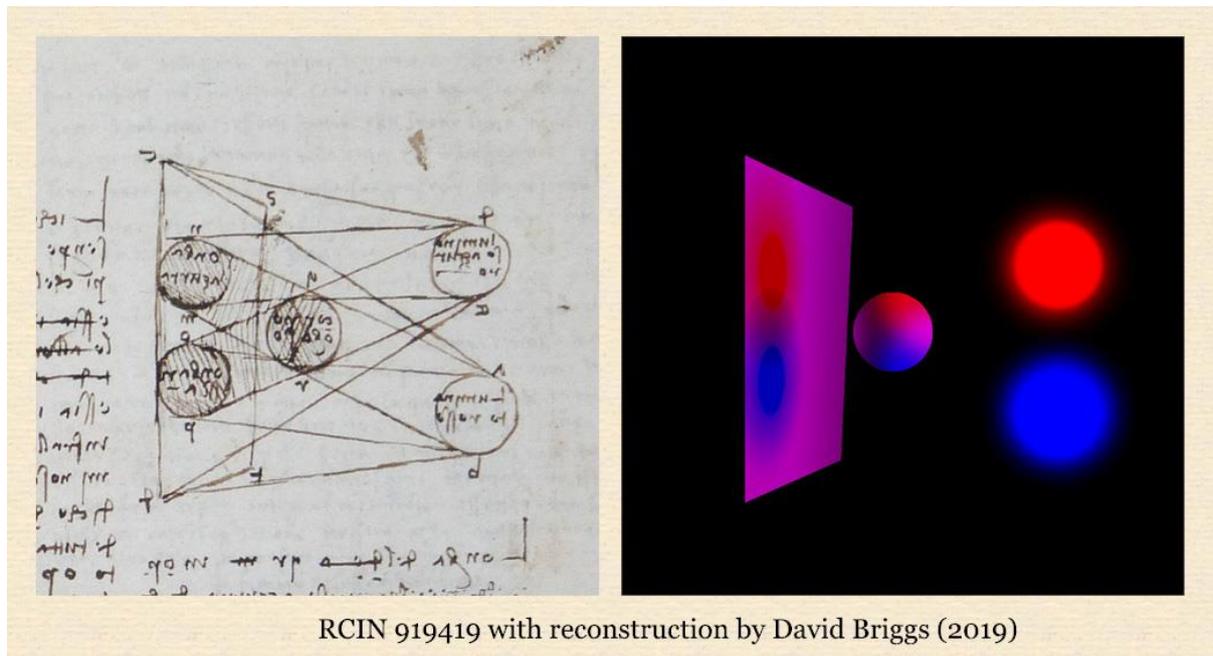


Virgin of the Rocks (London), detail

The reflected lights of dense and lustrous bodies are of much greater beauty than the natural color of those bodies, as is seen in folds of gold cloth that are open, and in other similar objects, since one surface reverberates on that opposite and the other reverberates on it, and they do this successively to infinity.

Codex Urbinas, 227 (McMahon 782)

We conclude with just two more examples, a notebook diagram from the Royal Collection where Leonardo investigates the effect of illumination from two coloured light sources, and one of his innumerable observations on atmospheric perspective.



References

- Ackerman, James S. (1980). On Early Renaissance Color Theory and Practice. *Studies in Italian Art History 1: Studies in Italian Art and Architecture 15th through 18th Centuries* (1980), pp. 11-44.
- McMahon, A. Philip (1956). *Treatise on Painting by Leonardo da Vinci*. Princeton University Press, Princeton, New Jersey.