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## On "Galileo's visions: Piercing the spheres of the heavens by eye and mind"

Birgitta Dresp

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Bookreview on Marco Piccolino, Nicholas J. Wade (2014): *Galileo's Visions-Piercing the spheres of the heavens by eye and mind*, Oxford University Press

Birgitta Dresp-Langley

*ICube, UMR 7357 CNRS, Université de Strasbourg*

In 1609 an optical instrument consisting of two lenses mounted at the extremities of a long tube, which permitted seeing things far up in the sky so clearly that they appeared as if they were right in front of the observer, was delivered to the city of Venice. Although this strange new object was much admired by the Venetian socialites, essentially for the beauty of its design, nobody seemed to see much more in it, or would have guessed what was going to happen: One man saw the object's potential, took it, and set it to work. He began observing the moon and the stars through it for long hours. The man's name was Galileo, a professor of mathematics from Padua who was about to change the course of history and, in the process, was to become a heretic in the eyes of the Church. Through that optical instrument, the telescope, Galileo would gain knowledge that was to shatter the established vision of the cosmos and give way to a new world order, one where man was to occupy a much more peripheral place. Looking at the heavens through that telescope, with a piercing mind behind his eyes, would enable Galileo to predict how the earth was likely to look when seen from the moon, centuries before NASA was to produce the first satellite images. It would lead him to understand some of the most fundamental interactions between light and matter, the limited ability of our senses, and the many ways in which the physical environment determines our perception of reality.

Should you be tempted to think "oh no, not another book about Galileo" you should reconsider. This new book entitled 'Galileo's Visions', by Marco Piccolino and Nick Wade, starts where other books have stopped. It tells us everything about Galileo that you will not

find on *wikipedia*. Beginning with the tale of the delivery of the telescope to Venice, the authors take us on a journey through Galileo's private intellectual universe, from his thought experiments about the luminance of the moon to the man's early insights into the complex interactions between light and matter, based on his observations of nature. These preceded Newton's conclusion that there is no colour without light (1704), and Newton's own *colour theory*, by almost a century, and the discovery of *structural colour* in biological tissue of animal species (e.g. Osorio and Ham, 2002, Dresch and Langley, 2006) by four centuries.

Step-by-step, accompanied by witty visual artwork by Nick Wade, we are made familiar with Galileo's early intuitions about physical and perceptual phenomena, addressed by science only centuries later. Transcripts of the man's private writings include fictive conversations where his alter ego *Salviati* addresses *Sagredo*, a Venetian aristocrat and like-minded friend, frequently interrupted by *Simplicio*, a fictive character, eager defender of classic cosmology. In those days of intellectual darkness, when *Simplicio* and the rest of the world believed that the earth was flat and that there was a day and a night because the sun travelled around it, Galileo nursed his own ideas about the universe and physical reality, and he produced a series of texts, which are the basis of this book. These texts deal with man's extraordinary ability to gain insight into complex physical phenomena through systematic observation of nature. Such ability provided him with an understanding, well ahead of its time, of the ways in which our brain perceives the world. In the allegorical language of fables, Galileo recounts the voyage that leads the human mind to knowledge. Through extracts from these fables, we discover what he already knew then, about the importance of individual experience in our capacity to *discriminate* and produce *sounds* (e.g. Claude, 2007), for example. We learn about different, diffuse or mirror-like, reflections of the world, and that there is a difference between the *visual mechanisms* of seeing objects that reflect light and objects that do not (e.g. Jacobs, 2008).

In a series of thought experiments, Galileo articulates comparisons between the brightness of the sun to that of the moon, under varying conditions. These thought experiments not only led him to infer that the earth illuminates the dark part of the moon more than the moon illuminates the earth, but also led him to understand about *lightness constancy* (Gilchrist, 2006) and *simultaneous contrast* (Chevreul, 1839), physiological optics and the importance of being able to recognize objects under varying conditions of illumination, or reflection of light from these objects. Galileo had insight into the effects of *aerial perspective* (Ross, 1967) and relative object size on our perception of what appears nearer and what appears further away from us (Dresp et al., 1993-2014), well before Leonardo da Vinci (1651) listed them in his *Trattato della Pittura* as two of the most important monocular cues to visual depth. He knew a lot about the physical nature of light and the phenomenon of *diffraction* (Bragg and Bragg, 1915) well before *UV* and *infrared wavelengths*, which the human senses cannot perceive, were discovered and measured. Also, it appears that Galileo had opinions on Copernicus' and Kepler's theories which may surprise more than a few. Galileo knew that the size of the moon and the stars would be overestimated when viewed through a telescope at night, and one of the problems he set out to resolve late in life was that of determining the relative position of the moon and the stars more accurately, on the basis of experiments comparing observations at night and day. However, this was not to be, as his failing vision finally compromised these plans.

I very much enjoyed reading this book, which is all about a professor of mathematics with an aversion to formalism, and a strong attraction to nature, to the animal kingdom, to phenomena of lights and shadows, to art, and to literature. I would have enjoyed the pictures in the book even more had they been printed in colour. The lacklustre monochrome representations do not seem to do their author justice. Yet, what the image reproduction lacks

in hue, the storytelling makes up for by an entertaining style, rich in details and references.

You will not tire of it.

Recently, scientists have discovered new particles that do not seem to obey conventional laws of physics (Bazavov *et al*, 2014). Phenomena such as brain-to-brain communication (Grau *et al*, 2014) are now being investigated in respectable research laboratories, and it seems that there are still so many limitations to our knowledge, maybe more than we realize, be it about the universe, or about the capacity of our brains to perceive and communicate. If Galileo lived today, his piercing mind would definitely have to be reckoned with!

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