The Optics of Giovan Battista Della Porta (1535–1615): A Reassessment
Workshop, TU Berlin, October 24–25, 2014, Room H 2051

NB: For each speaker 60' are foreseen, of which 30' for the talk and 30' for the discussion

Friday October 24th

9:15-11:30

Welcome/Introduction (15')

Willian Eamon, *A theater of experiments: Della Porta and the scientific culture of late Renaissance Naples*

Sven Dupré, *Secrets and experiments: Della Porta's optics between reading and doing*

11:30-12:00 Coffee Break

12:00-13:00

A. Mark Smith, *Giambattista Della Porta's theory of vision in the* De Refractione *of 1593: Sources, problems, implications*

13:00-14:30 Lunch break (Cafè Campus)

14:30-16:30

Riccardo Bellé, *Francesco Maurolico, Giovan Battista Della Porta and their theories of refraction*

Robert Goulding, *Della Porta's refraction models: Ray tracing or black boxing?*

16:30-17:00 Coffee Break

17:00-19:00

Yaakov Zik and Giora Hon, *Giovan Battista Della Porta (1535–1615): A magician or an optician?*

Arianna Borrelli, *The function and status of the "cathetus" line in Della Porta's optical writings*

ca. 20:00 Conference dinner

Saturday October 25th

9:30-11:30

Tiemen Cocquyt, *Material aspects of optical technology in Della Porta's final years: a recently discovered spyglass from the early 17th century*

Fokko Jan Dijksterhuis, *Della Porta readings in the North*

11:30-12:00 Coffee break

12:00-13:30

Albrecht Heefer, *Looking for invariances in geometrical diagrams: Della Porta, Kepler and Descartes on refraction*

Antoni Malet, *Concluding remarks* (30')

A Theater of Experiments: Della Porta and the Scientific Culture of Late Renaissance Naples

William Eamon, New Mexico State University

This paper is an exercise in rethinking Della Porta's experimental method. Rather than focusing strictly on optics, I intend to give an overview of Della Porta's scientific methodology, with particular attention to placing his thought into the context of 16th century Neapolitan culture. The Counter-Reformation and the aristocratic, courtly culture of the Spanish Kingdom of Naples provide the broad context for my paper; while the philosophical tradition of southern Italian naturalism provides the intellectual context. In my paper, I will try to characterize Della Porta's experimental method, which was governed by the protocols, aims, and theoretical assumptions of natural magic. My aim is to situate Della Porta's optical experiments into this broad social, intellectual, and cultural milieu.

Secrets and Experiments: Della Porta's Optics between Reading and Doing

Sven Dupré, MPIWG, Berlin

This paper is primarily concerned with Della Porta's *Magia naturalis*. It will situate the book within the wave of books of secrets and recipe literature in this period. My focus is on Della Porta's sources. Although the book is presented as a series of secrets and experiments, the *Magia naturalis* is based on a diversity of written sources in print and manuscript (such as Ettore Ausonio and Oronce Fine), which Della Porta extracted and transformed into separately identifiable units (that is, secrets). However, other secrets were (partly) based on informal conversations with mathematicians and artisans. Beyond the identification of Della Porta's sources this paper reveals the dynamic between reading and experimenting in Della Porta's *Magia naturalis*. It argues that Della Porta's transformation of his written sources, resulting from his reading practices, made it possible that his book was read as a source book of experiments in the seventeenth century by Johannes Kepler and Francis Bacon.

Giambattista Della Porta's Theory of Vision in the *De refractione* of 1593: Sources, Problems, Implications

A. Mark Smith, University of Missouri

In both the *Natural Magic* of 1589 and the *De refractione* of 1593, Giambattista Della Porta likens the eye to a camera obscura, the pupil serving as a narrow "window" through which images from outside are projected onto the screen of the crystalline lens. This, as Kepler recognized, was a major insight. Yet even a cursory look at Della Porta's account of vision in the *De refractione* shows that, far from being guided by this insight, he ignored it completely, the result being that his theory of sight conflicts with the idea that the eye acts like a camera obscura. It is my aim in this paper to explain precisely how the two conflict and, in the process, to suggest some possible sources and implications of that conflict.

Francesco Maurolico, Giovan Battista Della Porta and their Theories of Refraction

Riccardo Belle', University of Pisa

Both Maurolico and Della Porta wrote about refraction in their works; both of them tried to find a mathematical law explaining this phenomenon; both of them were interested in light rays passing through glass spheres and the list of analogies could continue. But, although themes treated were very similar, their approaches were very distant, since Maurolico and Della Porta were very different as scholars: the first one was a skilled mathematician, devoted to the restoration of ancient Greek geometry, the second one a very eclectic polymath, sometimes renowned as magician, interested especially in experimental and astounding phenomena, natural or artificial. In my presentation I will compare these two approaches with flaws and values. Only with the successful union of these approaches, by the end of the XVI century and the beginning of the XVII century the law of refraction will be tackled by other skilled scientist, which took advantage of Maurolico and Della Porta experiences.

Della Porta's Refraction Models: Ray Tracing or Black Boxing?

Robert Goulding, University of Notre Dame

Della Porta's method for calculating refraction represented a radical break with the whole tradition of optics that preceded him. Rather than considering the incident ray and the angular effect of each interaction with a refractive surface ("ray tracing"), della Porta treated each optical apparatus as a "black box," which, as an entire object, caused the incident ray to emerge at a different angle (or, more precisely, at a particular *place*). It was possible -- as Thomas Harriot did -- to subject Della Porta's models to rigors of ray tracing and thereby derive an expression for the effects of refraction at each interface, but this was possible *despite* Della Porta's analysis of refraction, not because of it. Della Porta occupies a very odd place in the history of refraction, such that any claim that he influenced subsequent theorists has to be treated with the greatest caution.

Giovan Battista Della Porta (1535–1615): a magician or an optician?

Yaakov Zik and Giora Hon, University of Haifa

In Bk. 17 of *Magia naturalis* (1589) Della Porta discussed the working of mirrors and lenses of various shapes and setups. He portrayed wide variety of wonders and visual effects that could be presented to the eye by optical elements. Della Porta aimed at describing how one could generate visual effects by applying optical elements rather than explaining their optical properties. In so doing Della Porta used two different epistemological terms (1) a qualitative term when addressing what an observer can see, and (2) a quantitative term when addressing the actual-physical point at which light rays were concentrating by reflective and refractive elements. This is evident from the optical nomenclature and the method of inquiry he developed. Della Porta was well familiar with the circumstances in which the image seen in concave spherical mirrors and convex lenses depends upon the relative locations of the eye, the object, and the optical element. The image can be of the same size as, larger than, or smaller than, its object depending on its relative position. The image can also appear reversed or upright as a function of the positioning of the eye in front or behind the point of inversion (*punctum inversionis*). Della Porta associated the point of inversion qualitatively with a locus—not a geometrical point—where the image seen by the eye is turned reverse or upright as a function of the placement of the optical element in relation to the observer's eyes. In this book, when addressing the actual-physical properties of reflective and refractive elements, Della Porta used a different term from the *punctum inversionis*. He referred to the burning point (focal point) of the optical element, that is, a geometrical point where the concentrating rays ignite fire. Della Porta asserted that the burning point of a concave spherical mirror is located on the optical axis at a distance equals to 1/4 of the mirror's diameter. For further scholarly explanations Della Porta referred the reader to his other optical book, that is, *De refractione*, which he formally published in 1593 but evidently was available earlier. In this book Della Porta explained, *inter alia*, the innovative geometrical method he developed for determining the burning point of concave spherical mirrors as a function of the mirror's radius curvature and the height of the incident ray. While this knowledge, governed by the law of reflection, was well established towards the end of the sixteenth century the principles governing refraction were of a mystery.

In *Magia naturalis* and *De refractione* Della Porta noted that concave and convex mirrors, as well as non-equal transparent bodies (lenses, prisms), deceive in delivering the images. *De refractione* was an optical manifesto providing the first-ever exploration of the principles of reflection and refraction in spherical mirrors and lenses and of their relevance to the structure of the eye and the mechanism of vision. Following *De subtilitate libri xxi* ([1550] 1559) of Girolamo Cardano (1501–1576), in Book II of *De refractione*, Della Porta introduced the reciprocity between reflection and refraction as the framework for his study of refraction. For that purpose Della Porta explored and physically illustrated phenomena of refraction in glass spheres which he thought could illustrate the visual faculties.

Della Porta’s scheme of refraction amounts to a quantitative approximation for tracing rays incident at various angles of optical interfaces. Excluding confusing qualitative considerations of image formation and visual perception, which have nothing to do with the actual-physical properties of optical elements, Della Porta developed a method by which one can trace the path of a refracting ray to a point where it cuts the optical axis of the interface. This was the only available quantitative approximation of refraction at the time. The scheme resulted in the following geometrical correlations:

1. The relation between the radius of curvature and the angle of reflection/refraction of the incident ray; and,
2. The relation between the radius of curvature and the point at which the reflected/refracted rays intersect with the optical axis.

These are elements of a theory by which specifications of lenses can be calculated and produced accordingly. Della Porta thus suggested an approximation which skilled opticians, using a straightedge, compass, and table of chords, could apply in their practice.

Against this background, we will seek in our paper to respond to the following questions:

1. Did Della Porta apply a well-developed experimental methodology?
2. The presupposed reciprocity of reflection/refraction—Is this a hypothetical claim or a consequence inferred from some practice?
3. Did Della Porta physically experiment with refraction in glass spheres or was his practice merely an illustration of the phenomenon?
4. Did Della Porta’s optical insights have impact on contemporary optical theories band practices?

The function and status of the 'cathetus' line in Della Porta's optical writings

Arianna Borrelli, TU Berlin

In ancient and medieval optics the term „cathetus line“ was used to indicate the perpendicular to the reflecting or refracting surface which passes through the object being reflected or refracted. The line was introduced to deal with plane surfaces and served to determine the (apparent) position in three dimensional space of the image seen by an eye observing from a given position. Leaving (at least for the moment) the question aside, how these optical-geometrical constructions and the relevant concepts relate to modern ones, one has to recongize the fact that the cathetus line and the „cathetus rule“ stating how to employ it for image construction were a necessary component of optical-geometrical practices in pre-modern historical context. Some authors offered natural philosophical explanations of why the line had such an important role, while others were content to employ it to obtain empirically plausible results.

In the early modern period the cathetus line and rule were appropriated and modified to help deal with spherical surfaces: Ettore Ausonio did so for spherical mirrors and Della Porta for multiple refraction on spherical surfaces. Kepler rejected the notion of cathetus line on natural-philoosphical grounds and accordingly developed alternative methods of image construction. Later on, the cathetus came to be mostly looked upon as a misguided, obscure pre-modern notion. However, for Della Porta the cathetus line was a key heuristic tool in discussing refraction in glass sphere and lenses, albeit with different degrees of success as far as empirical plausibility of the results was concerned. Despite the importance of the cathetus line Della Porta did not discuss its natural philosophical status and did not explain the grounds of his specific choices in defining that line in the problematic case of multiple refraction and at times ran into trouble form the point of view of inner coherence. However, I shall argue that the cathetus line and rule (or, better: lines and rules, given the occasional ambiguities) fulfilled an essential function in Della Porta's study of refraction in lenses. The cathetus line was an indispensable means in constructing the first systematic, standardized descritpion and conceptualization of a broad range of optical experiences with glass spheres and lenses, a description and conceptualization which in turn allowed him to compare and connect these experiences and conceive them as manifestations of the same optical phenomenon which unfolded according to certain rules which involved, among other things, the cathetus line. How that phenomenon should be described and how it relates to later optical notions is a question which invites discussion, but it is my claim that it occupies and important place in the history of (geometrical) optics and deserves in-depth study. Moreover, a closer look at the function of the cathetus rule in Della Porta's writing also allows to address another important issue, namely that of the status of geometry/mathematics in his natural-philosophical work.

Material aspects of optical technology in Della Porta’s final years: a recently discovered spyglass from the early 17th century

Tiemen Cocquyt, Museum Boerhaave Leiden

`Una coglionaria’, bugger, is how Della Porta expressed his thoughts after examining a copy of the newly invented telescope, in a letter to Cesi in 1609. Clearly, the technological reality of the first telescopes was not in line with Porta’s existing aspirations in the field of optics, as exemplified in his *De Refractione*. In my talk I will discuss the material properties and limitations of optical technology around 1600, and point out how differing requirements for distinct applications brought about innovation in lens grinding techniques in the first half of the seventeenth century. In particular, my talk will center around a recently discovered spyglass, manufactured in the Dutch city of Delft in the first decades after the invention of the telescope. Belonging among the world’s oldest telescopes, the object is important in that a rich context can be associated with the piece, and because of its remarkably primitive construction. In that sense, it brings us closer to the earliest stages of telescope production. And therefore, it allows me to present it to you as a quite fitting illustration of Della Porta’s `coglionaria’.

Della Porta Readings in the North

Fokko Jan Dijkstrehuis, University of Twente

The writings of Della Porta were received in the Low Countries soon and very well. In 1566 Plantin published a (part) translation of the *Magia naturalis* and in the 1650s a new translation went through several editions in Leiden. In this way his work found its way into general learned circles. In the meantime notable savants such as Isaac Beeckman and Christiaan Huygens read and commented on his ideas, including those on light, refraction and image formation. Della Porta represented an alternative way of understanding optics and instruments that can also be traced outside literary circles. In this paper I explore these portian readings of optics and the readings of Della Porta's optics in the Low Countries, and how they were juxtaposed with other readings of the telescope.

Looking for invariances in geometrical diagrams: Della Porta, Kepler and Descartes on refraction

Albrecht Heeffer, Center for History of Science, Ghent University, Belgium

Mathematical reasoning with geometrical diagrams allows or even depends on a level of ambiguity and indetermination. When reasoning about any given triangle, one should make abstraction of the specific shape of a triangle shown in a figure. However, diagrams used for reasoning in optics are much more constrained. Such diagrams have to follow the specific laws of geometrical optics. When dealing with refraction, diagrams become even more constrained as angles and proportions between line segments will be determined by the refractive index of the media involved. However, when correctly drawn, these constrained diagrams provide new opportunities to reason about refraction. Diagrams which were originally derived from experimental setups such as the measurement of refraction become experimental instruments themselves. In this paper I will demonstrate how diagrams on refraction were instrumental in the discovery of the sine law of refraction. In particular I will show how a specific diagram (figure 42) in the *Paralipomena* assisted Kepler in looking for invariances of proportions under different angles of incidence. Eventually, Kepler failed in finding a quantitative law of refraction, but I will demonstrated that his basic hypothesis and methodology can lead to the discovery of the sine law.
Several theses have been formulated on how Descartes arrived at the discovery of the sine law around 1626. I here propose the new hypothesis that Descartes stumbled on the sine law from studying the geometrical diagrams from Kepler's *Paralipomena,* deducing that the ratio's *FR:FA*, *FN:FH* correspond with the sine's of the angles *FAC* and *FRC*, a ratio which remains invariant for the three angles of incidence. Remarkably, while Kepler complains in his Paralipomena, that he could not get hold of Della Porta's *De refractione optices* of 1593, his figure 42 is almost identical to that one Della Porta (Bk. 1, p. 17). Assuming that point O lies on the vertical axis and completing Della Porta's figure with the missing point G, the sine law can be 'read' as the invariance of the proportions *OG:AG* = *CG:HG* under different angles of incidence.