Mechanical models for light in eighteenth century: enhancing physics teachers' views of Nature of Science

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The importance of the introduction of Nature of Science (NOS) in science teachers' training courses has been widely discussed in literature (ABD-EL-KHALICK & LEDERMAN, 2000a). Researchers point out that one way to enhance science teachers', in our case, physics teachers' conceptions about NOS is through History and Philosophy of Science (ABD-EL-KHALICK & LEDERMAN, 2000b; IRWIN, 2001; ABD-EL-KHALICK, 2005; RUDGE & HOWE, 2007).

However, Lederman (1992) calls attention to a common belief that if the teacher had Nature of Science instructions, this will be directly transmitted in his lessons. As Abd-El-Khalick & Lederman (2000b) indicates, there must be an **explicit** approach of the Nature of Science aspects that can be discussed in a historical episode, in order to get an effective change in science teachers' views about Science.

In the present proposal, we analyze the mechanical models for light developed in Europe of the first half of eighteenth century. During this period, there was a significant influence of Isaac Newton's theories of light and colours presented in his *Opticks* (1704). Due to a diversity of circumstances – Newton's prestige, lack of criticism to corpuscular conception for light, among others –, Newtonian optics became the foundation of optical studies, especially in the first half of the century (CANTOR, 1983; FARA, 2002).

One of the most remarkable consequences of Newton's optics' striking influence was the development of mechanical models to explain optical phenomena, like refraction (MOURA & SILVA, 2007). The success of Newton's mechanical theories in the *Principia* (1687) and his own speculations about its use to explain optical phenomena stimulated natural philosophers to search for relations between the behavior of bodies and light. This encouraged the creation of a new Newtonian optics, based completely on mechanical assumptions, which barely remembered the original one (MOURA, 2008).

George Cheyne (1671-1743) was one the first to treat light through mechanics. In his *Philosophical principles of natural religion* – published in 1705, soon after the first edition of the *Opticks* –, he affirmed that light corpuscles were extremely small and ruled by the laws of mechanics. This was confirmed, for example, by the fact that the rays of light don't interfere on each others' path.

John Teophilous Desaguliers (1683-1744) considered in his *Physico-mechanical lectures* (1717) that materiality of light was evident only by observing simple phenomena, as reflection or refraction. In order to explain the last one, in the case of ray coming from a rare medium to a denser one (air to glass, for example), he developed the idea of two forces acting upon the ray of light. One of them was due the refracting body and the other due the "motion" of the ray. The combined effect of two resulted the observed deviation.

Wilhelm Jacob 'sGravesande (1688-1742) published in 1720 an influential natural philosophy textbook, the *Mathematical elements of natural philosophy*. Translated to english by Desaguliers, 'sGravesande's book contained discussions about several topics of Natural Philosophy, including optics. His major idea for light was the "space of attraction", which he used to treat refraction. According to him, there was a region near the surface of the refracting body on which the ray suffered the effect of an attraction force towards the body, causing its deviation and refraction. Similarly, Robert Smith (1689-1768) discussed in his prominent *A compleat system of optics* (1738) the "space of activity". The difference relies on the fact the in Smith's "space" there were zones of attraction – explaining refraction – and also of repulsion, explaining reflection.

Many others natural philosophers discussed different mechanical models, like John Rowning (1701?-1771), Richard Helsham (1682-1738), Benjamin Worster (1685-1726). All of them contributed to the consensual unfailing character of corpuscular conception of light.

The explicity study and discussion about the mechanical models could enhance many aspects of Nature of Science. We will emphasize two of them: the first is the influence of the prestige of scientists on the process of acceptance of their theories. At the beginning of eighteenth century, Newton was an important icon among natural philosophers' community, what facilitated the establishment of his optical ideas presented in *Opticks* and its union with mechanical theories of the *Principia*. The second NOS aspect is the possibility of having different explanations to one single phenomenon, in our specific case, the refraction of light. The mechanical models discussed above were full of implicit and explicit conceptual problems, which were not commented by their creators.

By treating explicitly the two NOS aspects we pointed above – and many others that can be gathered from it –, preservice and inservice physics teachers could develop a wider and critical understanding of Physics, and of Science at all. This can promote open discussions about the dynamic and complex relations of Science and its cultural milieu, leaving the way free for good and adequate Physics Teaching.

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