# AN EASTWARD DIFFUSION: THE NEW OXFORD AND PARIS PHYSICS OF LIGHT IN PRAGUE DISPUTATIONS, 1377–1409

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*Abstract*

This paper inquires into how the new techniques of 14th-century physics, especially the doctrines of the maxima and minima of powers and the latitudes of forms, were applied to the issue of propagation of light. The focus is on several Prague disputed questions, originating between 1377 and 1409, dealing with whether illumination has infinite or finite reach and whether illumination's intensity remains constant (*uniformis*) or is rather uniformly decreasing (*uniformiter difformis*). These questions are contextualised through examination of Oxford, Paris, and Prague sources of the era (John Dumbleton, John Buridan, Nicole Oresme, Albert of Saxony, Henry of Langenstein, John of Holland) to construct a fresh survey of late medieval theories of light. Along the way, the discovery of a hitherto unknown Prague disputation from the 1370s is announced, and new evidence for the dating and Central European dissemination of Jacobus de Sancto Martino's *De latitudinibus formarum* and Nicole Oresme's *Questiones super Geometriam* is uncovered.

## *Introduction*[*]

In terms of light and its propagation, medieval natural philosophy revolved around three issues: the *speed* of light, the *intensity* of both the light source and the illumination, and the (maximum) *distance*

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from the source reached by the illumination.[1] Putting aside the first issue, this paper focuses on the interconnected issues of the intensity and the reach of illumination.[2]

In medieval Latin philosophy, these issues were initially scrutinised in works on optics (*perspectiva*) by 13th-century authors such as Roger Bacon, Witelo, and John Peckham, who usually based their accounts on Alhacen's (and Al-Kindī's) optical works.[3] The perspectivists conceptualised the *intensity* of light solely in terms of its "strength" (*fortitudo*). Roger Bacon's theory of the multiplication of causal effects (*species*), of which the propagation of light is a prominent example, implies that the *species* replicated through the medium along direct lines have to penetrate the density (*densitas*) or coarseness (*grossities*) of the medium and thus overcome its resistance.[4] Hence, what weakens the *species* is not the distance from the source *per se* but the necessity to overcome all parts of the resisting medium.[5] In Bacon's view, this is also why multiplication over an infinite distance is impossible: however rare the medium, it always resists the multiplication at least slightly, and thus the strength of the *species* sooner or later vanishes.[6]

1. Medieval authors usually distinguished between *lux*, the quality inhering in the light source, and *lumen*, the quality inhering in the medium, i.e., the (rays of) light propagated through the medium or the illumination. In the course of this paper, *lux* is translated as "light source," with the related terms *potentia activa* or *productiva lucis* as "(active) power of the light source" and *agens luminosum* as "luminous agent." On the other hand, *lumen* is rendered simply as "(propagated) light" or "illumination."

2. On the first issue, i.e., the medieval discussions on whether light propagation is or is not instantaneous, see D. C. LINDBERG, "Medieval Latin Theories of the Speed of Light," in: R. TATON (ed.), *Roemer et la vitesse de la lumière*, Paris 1978, pp. 45-72.

3. For general accounts of these authors, commonly labelled "perspectivists" (*perspectivi* or *perspectivistae*) in late medieval sources, see D. C. LINDBERG, *Theories of Vision from al-Kindi to Kepler*, Chicago 1976, pp. 18-32, 60-86, 107-132, and A. M. SMITH, *From Sight to Light: The Passage from Ancient to Modern Optics*, Chicago / London 2015, pp. 166-227 and 256-277.

4. ROGER BACON, *De multiplicatione specierum*, II.3, ed. D. C. LINDBERG, in: D. C. LINDBERG, *Roger Bacon's Philosophy of Nature*, Oxford 1983, pp. 112-114; ibid., IV.1, pp. 204-206. This presupposition goes back to Alhacen's and perhaps even Ptolemy's optics; see D. C. LINDBERG, "The Cause of Refraction in Medieval Optics," in: *The British Journal for the History of Science* 4 (1968), pp. 23-38, at pp. 24-29.

5. BACON, *De multiplicatione specierum*, IV.1, pp. 206-212. Another fundamental cause of weakening that Bacon proposes here is accidental multiplication: besides the direct passage, all *species* in the main ray disperse further accidental (or secondary) *species* in all directions, further weakening the main ray of multiplication.

6. ID., ibid., IV.2, p. 212; ibid., II.3, p. 112.

Indirectly, the strength of a light ray does decline with distance, and the perspectivists generally agreed that light (like every causal action) is stronger at points nearer to the luminous agent.[7] Witelo, inspired by Al-Kindī, further develops geometrical demonstrations regarding the strength of illumination, proposing that a body closer to the luminous source is illuminated more strongly than a more distant body, and that the same light source illuminates a smaller space more strongly than a greater one.[8] However, as evidenced below in section 4, medieval philosophers apparently did not understand the intensity of light as indirectly proportional to the distance from the source and not at all as indirectly proportional to the square of the distance, as Johannes Kepler and the modern inverse-square law do.

Several 14th-century scholars, such as Thomas Bradwardine, William Heytesbury, and John Dumbleton in Oxford, and John Buridan, Nicole Oresme, and Albert of Saxony in Paris (to mention just a few), developed new quantitative methods to study natural phenomena, drawing on arithmetic, geometry, and logic. Regarding the propagation of light, two of these techniques are especially important for the texts considered in this paper: the doctrine of setting upper and lower limits to the causal powers (*de maximo et minimo*) and the doctrine of intensity variations of natural phenomena and their geometrical representations (*de latitudinibus formarum*). Sometimes, these new methods are called "calculatory"; nevertheless, strictly speaking, the doctrine of *de maximo et minimo* does not involve any calculation or arithmetic, exercising instead the tools of the philosophy of language to solve limit-decision problems.[9] Besides, "calculatory physics" might suggest a direct

7. ID., ibid., V.1, p. 232; JOHN PECKHAM, *Perspectiva communis*, I.18{16}, ed. D. C. LINDBERG, *John Pecham and the Science of Optics*, Madison, Wisconsin / London 1970, p. 94: "In puncto propinquiori fortior est lux unius corporis quam in remotiori."

8. WITELO, *Perspectiva*, II.22, ed. S. UNGURU, *Witelonis Perspectivae liber secundus et liber tertius. Books II and III of Witelo's Perspectiva*, Wrocław / Warszawa / Kraków 1991, pp. 254-255; ibid., II.24, pp. 256-257; see also AL-KINDĪ, *De aspectibus*, 22, ed. H. HUGONNARD-ROCHE, in: R. RASHED, *Œuvres philosophiques et scientifiques d'al-Kindī, vol. 1: L'Optique et la Catoptrique*, Leiden / New York / Köln 1997, pp. 437-534, at pp. 518-519.

9. Cf. J. E. MURDOCH, "From Social into Intellectual Factors: An Aspect of the Unitary Character of Late Medieval Learning," in: J. E. MURDOCH – E. D. SYLLA (eds.), *The Cultural Context of Medieval Learning*, Dordrecht / Boston 1975, pp. 271-348, esp. at pp. 280-289, who speaks about "new analytical languages" in general, blending both

link to the so-called Oxford calculators, a group of English thinkers traditionally connected with the Merton College at the University of Oxford, active between the 1320s and 1340s.[10]

The range of investigation here is narrowed due to the paper's historical aim: it focuses on the milieu of Prague university in the era of its initial flourishing (ca 1360–1420) and aspires to uncover whether and to what extent the new physics of light was debated in Prague. Section 1 argues that the main source for such an endeavour is the outcomes of the (quodlibetal) disputations of the Prague Faculty of Arts. Besides the already known manuscripts with disputation materials, the paper announces the discovery of a hitherto unstudied set of questions preserved in a Warsaw manuscript and stemming from the 1370s Prague disputation(s), in which, among others, Conrad of Soltau participated. Of all these sources, four questions dealing with the propagation of light, its maximum reach, and intensity (from the 1370s disputation of anonymous masters, the 1390s quodlibet by Henry of Ribenicz, and the 1409 quodlibet by Matthias of Knín) are singled out and analysed in the course of the paper; three are edited in the appendix.[11]

The considerable density of these Prague questions can be unpacked only by proper contextualisation. Delineating the conceptual, theoretical, and textual background of the potential sources obviously cannot be restricted to the so-called Oxford calculators. The construc-

quantitative calculatory techniques and the qualitative logical methods of, e.g., the doctrine of limits of the natural power. This catchall approach of "new analytical languages" has remained popular down to current research; see, e.g., G. FERNÁNDEZ WALKER, "Nicholas of Autrecourt's *Quaestio de intensione visionis* Revisited: The *scola Oxoniensis* and Parisian Masters on Limit Decision Problems," in: *Vivarium* 55 (2017), pp. 152-169. Cf. however M. THAKKAR, "Wyclif, the Black Sheep of the Oxford Calculators," in: D. A. DI LISCIA – E. D. SYLLA (eds.), *Quantifying Aristotle: The Impact, Spread and Decline of the Calculatores Tradition*, Leiden / Boston 2022, pp. 186-214, at pp. 194-203, calling for more cautious discrimination between calculatory and non-quantitative techniques.

10. See again ID., ibid., pp. 187-203 for an up-to-date analysis of the label "Oxford calculators," which is of modern coinage, with its historiographical background, and a checklist of conditions to be fulfilled to call a theory "calculatory".

11. While the questions from the 1370s disputation and Knín's quodlibet are relatively short and devoted exclusively to the quantitative theories of light propagation, the question from Henry of Ribenicz's quodlibet is much longer and broader in its scope: discussing maxima of active potencies in general, it deals with light sources only partially. Therefore, I decided to include full-fledged editions of the former three questions (see the appendix) and transcriptions of only the part related to light from Ribenicz's question (see the respective footnotes in section 3).

tion of the textual corpus is geographically driven: the source texts evidently used by Prague university scholars between 1360 and 1420 are considered here. The "evidence" is twofold: the existence of a manuscript copy originating from or used at Prague university, and/or textual borrowings from such a treatise in Prague sources. Hence, a broader spectrum of authors elaborating on the new physics of light is considered, suggesting a predominance of Paris over Oxford sources, namely: John Dumbleton for Oxford (incidentally, no sign of the use of Richard Swineshead has yet been detected in Prague); John Buridan, Albert of Saxony, Nicole Oresme, and Henry of Langenstein for Paris; and John of Holland for the indigenous Prague sources. (Section 2)

Sections 3, 4, and 6 scrutinise the Prague questions in the broader context of the debates on whether the reach of the light propagation is infinite or limited, and whether the intensity of propagated light is constant or (uniformly) decreasing. These sections can also be read as applications of the medieval doctrines *de maximo et minimo* and *de latitudinibus formarum* to the specific phenomenon of light propagation. Along the way, new evidence regarding the manuscript distribution of some source texts is uncovered; specifically, the paper documents the use of Jacobus de Sancto Martino's *Tractatus de latitudinibus formarum* in the 1370s Prague disputations, which might be the earliest sign of the reception of this text in Central Europe (section 5), and hypothesises about the presence of a copy of Nicole Oresme's questions on Euclid's *Geometry* in Prague, excerpted in Matthias of Knín's quodlibetal handbook in 1409 (section 6).

The paper connects several areas that separately have enjoyed some limited attention from modern scholars. First, the propagation of light has been studied by historians of optics (David C. Lindberg), who, however, primarily focused on its refraction, reflection, rectilinearity, and other optical properties. Second, the contributions of the new 14$^{th}$-century physics to the study of light have been acknowledged only partially, especially in the context of the debate between John Dumbleton and Richard Swineshead (Edith D. Sylla, Robert Podkoński). Third, the reception of the new physics in Central Europe is not *terra incognita,* but again it has been investigated without considering light-related topics specifically, e.g. by Marshall

Clagett, focusing mainly on mechanics, and Daniel Di Liscia, focusing on the latitudes of forms doctrine and without considering Prague university. Intertwining these three research areas and examining manifold unpublished manuscript sources, the paper aspires to present a fresh take on the initial stage of reception of the new physics of light at Prague university in the late 14th and early 15th centuries.[12]

## 1. *Prague sources: Quodlibetal disputations and a newly-found set of questions from the 1370s*

The late 14th- and early 15th-century Prague university production was not particularly abundant in original treatises or commentaries on scientific or natural philosophical matters. Many lecturers took the liberty of basing their lectures on commentaries by more famous Paris and Oxford scholars, as allowed by the statutes of the Faculty of Arts.[13] In such an atmosphere, the outcomes of various disputation practices represent more substantial evidence of Prague scholars' genuine interests. Among the ordinary disputations, disputations on *sophismata* and promotional questions, the quodlibetal disputation stands out in terms of both academic prestige and the richness of research areas covered,

12. Unless otherwise indicated, all transcriptions of manuscript sources quoted *in extenso* or merely referred to in this paper were made by the author. These transcriptions quoted in the footnotes follow the editorial principles presented in the appendix. The following library name abbreviations are used in the references to the manuscripts: KMK for the Prague Metropolitan Chapter Library ("Knihovna metropolitní kapituly"), BJ for the Cracow Jagiellonian Library ("Biblioteka Jagiellońska"), ÖNB for the Vienna National Library ("Österreichische Nationalbibliothek"), and UB for the Erfurt, Leipzig, and Greifswald university libraries ("Universitätsbibliothek").

13. *Statuta facultatis artium universitatis Pragensis redacta anno 1390*, I.8, in: F. Šmahel – G. Silagi, *Statuta et Acta rectorum Universitatis Carolinae Pragensis 1360–1614*, Praha 2018, pp. 227-275, at pp. 235-236. This article of the statutes determines that masters are allowed either (1) to teach their own commentaries on the textbooks (*propria dicta dare*), or (2) to dictate (*pronunciare*) commentaries by famous masters of Prague, Paris, or Oxford universities (*ab aliquo, vel aliquibus, famoso vel famosis de universitate Pragensi, Parisiensi, vel Oxoniensi magistro vel magistris compilata*); whereas in the case of Prague bachelors (1) is forbidden and (2) prescribed. *Pronuntiatio* was a specific practice of the oral transmission of texts; see, most recently, L. Campi, "A *Quaestio* on Friendship Ascribed to Matthias of Knín with Some Notes and Questions on the Academic Practices and Intellectual Life at the Prague Faculty of Arts at the Turn of the Fifteenth Century," in: *Documenti e studi sulla tradizione filosofica medievale* 32 (2021), pp. 297-343, at pp. 323-326.