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THEMATIC DOSSIER

TOWARDS A GLOBAL HISTORY OF ECLIPSES.

ENTANGLEMENTS OF DISCIPLINES, ACTORS, AND PRACTICES

## An Introduction from the Guest Editors

**Deborah Kent**

School of Mathematics and  
Statistics, University of St  
Andrews, UK

dk89@st-andrews.ac.uk

**Clemency Montelle**

School of Mathematics  
and Statistics, University of  
Canterbury, New Zealand

clemency.montelle  
@canterbury.ac.nz

**Ana Simões**

Centro Interuniversitário de  
História das Ciências e da  
Tecnologia, Faculdade de  
Ciências, Universidade de Lisboa,  
Portugal

aisimoes@fc.ul.pt

Eclipses of the Sun and Moon have been a source of human fascination since early times. From the rudimentary recognition of eclipse recurrences to highly sophisticated mathematical modelling and theorising to account for more subtle periodicities and features, eclipses have inspired thinkers to advance forms of scientific inquiry in both direct and nuanced ways. The intellectual and cultural activities surrounding these celestial events are strikingly global in scope. Yet, despite this widespread and continuous engagement, historical narratives of eclipse reckoning remain geographically narrow and studies are often dominated by sources and voices carrying the interests of specific regions and influenced by contemporary geopolitical boundaries, national institutions, and celebrated scientific figures. This special issue seeks to challenge such siloed approaches and expand the study of eclipse reckoning to reflect its broader, more diverse history.

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A move towards a more globally inclusive approach to the history of eclipse reckoning allows for a more comprehensive exploration and articulation of rich interactions between and among regions, communities and their institutions. In eclipse observational contexts, practitioners were often testing their ideas and methods during these brief and time-delineated opportunities that required multi-disciplinary expertise and extensive logistics. The study of eclipse reckoning and observation likewise demands a wide range of mathematical, technical, socio-cultural, and historical expertise to uncover commonalities and circulation amongst historical cultures of inquiry. Existing scholarship invites further work that can encompass a unity of approach alongside distinctiveness, for a much richer insight into the ways in which humans have engaged with eclipse phenomena.

First and foremost, eclipses are visually spectacular events. The dramatic celestial occurrence of an eclipse provided cultures of inquiry from earliest times with strong inducements to model and account for this phenomenon. In ancient and premodern periods, various mathematically active societies generated key insights that were both culturally specific and diachronic: Iterative and approximation techniques were developed to establish eclipse possibilities; Trigonometry and spherical geometry were applied to account for parallax and produce ever more accurate planetary positions; measurement and empirically derived details generated data from which practitioners could refine their models. Features such as syzygy computations and parallax prompted the exploration of mathematical techniques to model eclipse limits, magnitude, and timing. These all required ever more sophisticated forms of numerical reckoning and recording, which subsequently were used to improve mathematical models of celestial phenomena. The breadth of mathematical models thus developed relied on associated computational procedures and practices. Numerical tables and graphical representations were crucial platforms for recording data and capturing quantitative and qualitative significance of eclipse phenomena.

Documenting how practitioners engaged with eclipses as observational phenomena can be approached in various ways. In some cases, historical eclipse observation involved major expeditions crossing geopolitical boundaries and depended on diplomatic efforts and, at times, even military engagement. These complexities significantly broaden our understanding of the institutional and individual actors involved, challenging more simplified narratives and revealing more nuanced acts of scientific heroism. In another approach, examining the specific social contexts of eclipse observation reveals a diverse array of stakeholders, both associated with the act of observing and in related dissemination and interpretation of findings, including visual artefacts that were prepared prior to or created after an eclipse event. Visual and diagrammatic representations of eclipses offer insight into the ways in which different cultures of inquiry responded to, promoted, or engaged others with these events, be it simply to document, to highlight specific aspects of the visual phenomena, or

to use as observational data to improve and refine astronomical models or scientific theory. Indeed, a broad chronological survey of observational practices testifies to the evolution of various traditions over time and space, and the ways in which they circulated among both the scholarly community and more general audiences.

The papers collected here emerged from an international workshop “A Global History of Eclipse Reckoning” held at the International Centre for Mathematical Sciences (ICMS) in Edinburgh in November 2024. Much as the implementation of eclipse observation involves a broad intersection of people, disciplines, and practices, the study of their history likewise benefits from a broad range of scholarly expertise. Accordingly, the workshop brought together scholars from varied backgrounds—with a wide variety of interconnected and complimentary skill sets—who have focused their attention on understanding historically and geographically specific eclipse-reckoning efforts. Central aims of the workshop were to share ways in which people in different times and places approached eclipse phenomena, to trace the circulation and development of related technical insights and practices, and to underscore the genuine value of the mathematics of eclipse-reckoning as a common human heritage. The papers in this volume demonstrate a variety of approaches to the study of eclipse observation, modelling and representation. They also evidence the benefits of multi-disciplinary collaboration for topics with such scope.

Two of the papers consider scientific expeditions as a significant endeavour to engage with the visual aspects of eclipse phenomena. The work involved in organizing and implementing expeditions to observe eclipses was a massive operation, an endeavour which gained increased importance throughout the nineteenth century with the use of astronomy by European powers to assert their hegemonic status in the chessboard of nations. Efforts to observe eclipse totality depend on logistical support that typically require cooperation from different astronomical communities, as well as on skilled and unskilled work delivered by actors often left unnamed in the record. The scientific work of eclipse observation itself stands at the crossroads of mathematics, astronomy, physics, geography, and politics. Practitioners of astronomy intersected with political domains and agencies of empires as they travelled the globe to pursue eclipse totality.

Over the course of the nineteenth century, growing transportation networks altered the scale and extent of eclipse expeditions while new technologies enhanced observational potential. Starting in the 1840s, the refinement of photographic materials and techniques facilitated photos of celestial objects. While the first known photograph of the solar corona was captured in 1851, it was an image obtained during totality in 1860 that gained widespread publicity. The triumph of the coronal photograph raised new questions about valid research methodology and criteria for accepting or validating a scientific result. After the 1868 success of identifying in the corona the spectral line for a new element called

Helium, the tools of spectroscopy further expanded the scientific possibilities of eclipse observation. In fact, the total solar eclipse on 18 July 1860 can be interpreted as demarcating a boundary between astronomy and astrophysics in the science of eclipse observation. Further, the location of this total solar eclipse—with a path of totality spanning North America, Spain, and Northern Africa—meant it was accessible to observers in diverse geographical and socio-political contexts. Various international, national, institutional, and personal infrastructures shaped expedition logistics.

To consider a broad history of the 1860 total solar eclipse thus requires diverse expertise. The collaborative approach to the first paper in this volume, “Towards a Global History of the 1860 Total Solar Eclipse,” reflects the benefit of bringing a similar breadth of expertise to the scholarly investigation of this eclipse. Together, co-authors Deborah Kent, Jesse Garrison, Megan Briers, Ileana Chinnici, Frédéric Soulu, and Daniel Belteki lend extensive knowledge of British, French, Spanish, Italian, Algerian, and North American expedition parties. While it is, in some respects, essential to consider the particularities of expeditions that exist in national categories centred on resources and institutions, the authors also seek to generate a broader approach. Even with circumstances and funding that vary among observation parties and even between individuals, many observers shared collocated destinations and similar scientific goals for the astronomical event. In 1860, observers hoped the total solar eclipse would provide information about the red solar prominences and insights on the nature of the solar corona, alongside opportunities to check the precision of lunar tables and test geodetic methods. These scientific goals provide a connective thread that unifies disparate eclipse expeditions. In this light, the paper emblematises the richness of insight to be gained from a global approach to the history of observing eclipses, through the scientific expeditions connected to the total solar eclipse in 1860.

The second paper likewise proposes a global perspective of the most famous eclipse expeditions: the British parties that observed the 1919 total solar eclipse in Sobral, Brazil and Príncipe. This contribution emerged from work being done at the Centro Interuniversitário de História das Ciências e da Tecnologia as part of a large-scale project entitled “Einstein, Eddington and the Eclipse: Towards a Global History of the 1919 Eclipse.” The paper, authored by team members Ana Simões, Cristina Luís, Hugo Soares, Samuel Gessner, and Luís Miguel Carolino, considers scientific practice in its social, geographical, and world-political context, in contrast to existing narratives that focus on exchange of scientific arguments in an almost disembodied realm of ideas. As such, it redirects historical attention from the aftermath of the expeditions, relativity and Einstein’s rise to the expeditions themselves and the myriad actors and contexts (social, geopolitical and religious) which made these outcomes possible.

The move towards a global approach of the 1919 eclipse includes considerations of actors in context, observing totality, the eclipse lineage, and the notion of the ‘eclipse on paper’. With such an interpretative frame, the authors assess the role of a multitude of actors who made the expeditions possible. They include all British expeditioners, not just Eddington, and also consider the role of supporting actors, such as the astronomers of the national observatories of Brazil and Portugal, among whom stood the Brazilian director Morize and the Portuguese deputy-director Oom, as well as local elites, technical experts and workers under various labour regimes. The authors detail the role of various people in pursuit of totality at the culmination of the expedition, revealing the extent of colonial and racial dimensions relating to the eclipse event that have never been so prominently brought to light before. In terms of legacy, the authors argue that the impact of the observations of the 1919 eclipse cannot be adequately understood without including it in a lineage of eclipses that were observed to test light bending, both before and immediately after 1919. Finally, in the section focusing on “eclipse on paper,” the authors investigate the circulation of knowledge of the eclipse event from a broad range of sources from astronomical experts to the public realm using newspapers as historical sources. Incorporating the medium of newspapers allows the authors to assess how different audiences, for instance, newspaper readers in Brazil, Portugal, UK, USA and Germany in the period from 1 January, 1919 to 31 December, 1920, became aware of the 1919 eclipse and its importance for corroborating Einstein’s theories.

The last paper shifts focus from the logistics and impact of eclipse expeditions to diagrammatic and graphical approaches to eclipse events, investigating visual practices attested in textual sources from the Indian subcontinent and Europe in the second millennium. In “Visualising Eclipses: Graphical Constructions of Eclipse Phenomena in the Sanskrit Astral Sciences,” Jambugahapitiye Dhammaloka, Aditya Kolachana, and Clemency Montelle focus on diagrammatic practices associated with eclipse reckoning in Sanskrit sources in the astral sciences. Through distinctive passages drawn from seminal second millennium Sanskrit astronomical treatises, the authors explore instructional sections which guide the reader through a set of constructions to depict graphically a specific eclipse occurrence. They highlight the salient features of these procedures noting similarities as well as differences between the accounts and how theory and observation informed manual practice. Ultimately, it appears that these diagrammatic representations were intended to be based on precomputed data and produced prior to the eclipse event. The resulting visual artefact was then to be used to compare against the actual event, prompting live observers for what they should look for and emphasising particular features of the individual eclipse. One remarkable feature of this aspect of eclipse reckoning is that as a practice it remained largely unchanged for over a millennium.

In sum, the three papers included in this issue cluster in two groups. The first pair investigate myriad factors in the organization, implementation, and aftermath of eclipse expeditions arranged to observe the total solar eclipses of 1860 and 1919 respectively. The third paper addresses the role of visual cultures found in second millennium astronomical scholarship in two distinct geographical contexts. The first group of papers emphasise the commonalities and differences between different expeditions arranged to observe total solar eclipses; a common theme that arises is their crucial dependence on geopolitical circumstances. For instance, the reason so many teams were mobilised to observe in numerous different localities in Europe, the US and North Africa in 1860, while in contrast, so few observed the total solar eclipse of 1919 in Brazil and the Portuguese colony in Africa, was a result of favourable circumstances with respect to geographical, social, political and technological dimensions in the first case in contrast with less favourable circumstances in the second. In this latter case, the Great War had just concluded, and observational locations were very far away for European as well as American astronomers; in contrast, geographical distance was not a concern for Brazilian observers. Furthermore, from an astronomical point of view, these two total eclipses were associated with distinctly different astronomical aims: the first coincided with an ever greater connection to astrophysics and the second provided an opportunity to test light bending. But both exemplify the various roles observing total solar eclipses could play in theory testing, from Newtonian and Einsteinian theories of gravitation to the development of new algorithms, and to the search for new planets such as Vulcan. They also show how carefully planned logistics was of paramount importance to ensure the success of eclipse expeditions and how much these expeditions relied on the cooperation among actors, from experts to elites and workers, on the networking abilities of scientific institutions, and on governmental support and other forms of sponsorship.

The last paper reveals the specificities of source material deriving from diverse astronomical traditions. The geometrical drawings in the Latin tradition and their various significances contrast sharply with diagrammatic representations arising from instructional passages soliciting manual execution in the Indian tradition. While visual cultures are not the focus of the first group of papers, the outputs of the two expeditions under analysis also relied crucially on visual representations. As both expeditions took place after the introduction of photographic cameras and spectroscopes in astronomy, which gave way to the rise of astrophysics, photographs augmented the corpus of hand-executed diagrams in definitive ways. Across time and space, visual representations figure centrally in both scientific and cultural engagement with eclipse phenomena.

Over time, numerate societies developed deeply sophisticated forms of eclipse science, which propelled advancements in mathematics in novel and unprecedented ways. The creation, use, and transmission of cultures of visual reasoning related to eclipse prediction and

observation strengthened a cross-cultural cohort of scholars with the vision of generating a coherent sense of shared ownership of the mathematical tradition of eclipse reckoning. But eclipse reckoning is just one part, albeit crucial, of the efforts involved in organizing and undertaking expeditions. The scientific work of eclipse observation stands itself at the crossroads of mathematics, astronomy, physics, politics, geography, and the ambient social climate. The pursuit of observing eclipse totality also crucially depended on logistical support that required cooperation from different astronomical communities. Indeed, in this respect, astronomical practice intersected with political domains and agencies of empires as practitioners travelled across the globe in pursuit of eclipse events.

Overall, these three papers, covering a wide range of astronomical cultures, geographies and periods, reveal that no one scholarly lens on its own can engage seriously in any attempt at a global history of eclipse reckoning. The various dimensions of eclipse science range from theoretical developments, empirical details arising from observation, scientific instrumentation, measurements and predictions, institutional, social and political dimensions involving team organization, division and regimes of labour, networks of observatories and circulation of events, heavy logistics, government funding, international cooperation or competition, and international diplomacy. For a fuller picture historians must go beyond Eurocentric narratives to address very different geopolitical contexts. Finally, they also include sociological dimensions associated with community interest and public perceptions. As such, and despite their apparent differences, all papers in one way or another touch common themes on which to ground global histories of eclipses. We hope that, as a collection, they inspire further such investigations that would amplify our historical understanding of this rich tradition of scientific inquiry and the pivotal role eclipses play as common cultural heritage.