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Academic Networks and Disciplinary Trends: A Study of Mathematical Philosophy

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Abstract

Background: Mathematical philosophy has evolved as a significant interdisciplinary field linking formal logic, philosophy of science, and foundation mathematics. Despite its growing impact, detailed investigation of its research patterns, collaboration networks, and knowledge structures has been lacking. This piece bridges the gap through examination of the field's evolution from 2015 to 2024, focusing on thematic shifts, intellectual drivers, and scholarly representation imbalances.

Objective: This study attempts to examine the constitution and dynamics of research communities in philosophy of science, formal epistemology, and bordering disciplines through the cataloguing of leading researchers, clusters, and potential hierarchies or biases in terms of co-authorship and citation behavior.

Methodology: A bibliometric analysis of 645 peer-reviewed articles (downloaded from lens.org) was conducted using VOSviewer and wordsift for visualizing the networks. Co-authorship analysis, citation mapping, keyword co-occurrence, and temporal trend analysis were methods used. Triangulation using qualitative content analysis ensured robustness.

Findings: Dominance by strong Europeans existed in citation clusters by authors like Richard Dawid and Stephan Hartmann as hubs. Close-knit groups of co-authors found close-knit communities in Bayesian epistemology and formal logic, while sparse interdisciplinary connections were newly emerging. Keyword analysis suggested a shift to computational tendencies, though traditional subjects persisted. Gender and geographic disparities existed, with non-Western participation understated.

Conclusion: The field boasts sound theoretical advancements but is marred by fragmentation and exclusionary gaps. Proposed recommendations include fostering cross-regional networks,

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addressing biases in citation, and exploring underserved subfields like applied mathematical ethics.

Novelty: This contribution is new in presenting a comprehensive bibliometric analysis of mathematical philosophy and merging quantitative network analysis with strict qualitative noting. It offers a reflexive architecture for the assessment of intellectual and social processes in the field.

Keywords: Mathematical philosophy, bibliometrics, co-authorship networks, citation analysis, epistemic diversity, formal epistemology, Bayesian reasoning, research trends.

Introduction

Mathematical philosophy occupies a special position between formal logic, philosophy of science, and foundation mathematics and is an interface between theoretical abstract inquiry and computational applicability (Choe, 2024; Avigad, 2007). The field has seen remarkable advancement during the past decade (2015–2024) due to advances in computational methods, Bayesian epistemology, and formal modeling tools (Haddad, 2025; Lenhard, 2022). These developments have not only expanded the domain of mathematical philosophy but also deepened its intersection with neighboring disciplines such as artificial intelligence, cognitive science, and theoretical physics (Storozhyk, 2024). Despite growing impact and interdisciplinary reach, the subject has so far been missing a systematic data analysis of its research streams, collaborative networks, and knowledge regimes (Purvis, Keding, Lewis, & Northall, 2023). This lack of literature has made it difficult to decide on the overall trend in the field, identify emerging trends, or see potential imbalances in scholarly representation. This present study fills this gap by applying strict bibliometric methods to analyze 645 journal articles, giving the first general mapping of the growth of mathematical philosophy as a standalone research field.

The intellectual roots of mathematical philosophy trace back to revolutionary work in the early 20th century by Gottlob Frege, Bertrand Russell, and Rudolf Carnap, introducing for the first time the use of formal systems of logic to address traditional philosophical problems (Delacampagne, 2001). These early efforts established a tradition of rigor and precision that still characterizes the field today, as well as laid the groundwork for contemporary explorations into probability theory, modal logic, and the philosophical basis of computation. Modern mathematical philosophers have leveraged this tradition by developing formal riches to address problems in epistemology, metaphysics, and the philosophy of language, often importing tools from mathematics and computer science (Tanswell & Rittberg, 2020). The field's interest in these diverse areas of inquiry is a reflection of its unique capacity to subject mathematical rigor to philosophical investigation as well as to subject mathematical practice to philosophical scrutiny (Boadu & Bonyah, 2024). This two-way concern has made mathematical philosophy increasingly relevant to theoretical dispute as well as to practical application, particularly in areas like machine learning ethics, formal verification, and the foundations of quantum mechanics.

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During the last ten or so years, the dramatic proliferation of mathematical philosophy into specific domains such as computational philosophy, formal epistemology, and mathematical ethics has produced both wonderful opportunities and tremendous challenges (Ramsey & De Block, 2022). Even as the research options have been diversified to such a richness as to enliven the subject, they have also left a fractured terrain on which the connections between areas of research are sometimes obscure or ill-documented. Specialization of research has created difficulties for scholars to maintain a broad view of the progress of the discipline, which may undermine interdisciplinary co-operation and cross-breeding of concepts (Sugimoto, 2010). In addition, increasingly technical competence required to make a substantial contribution in numerous areas of mathematical philosophy has built hurdles to access that may exclude beneficial insight from outside the standard mathematical or philosophical training.

Objectives and Research Questions

This analysis tries to answer three primary questions: (1) What are the dominant research themes and their time trends in mathematical philosophy (2015–2024)? (2) How do co-authorship and citation networks capture collaboration styles and intellectual influence? (3) To what extent do geographic, institutional, and gender disparities affect the scholarship of the field? By probing these questions, the study provides a richer understanding of the structure of the field, its biases, and areas for improvement.

Significance and Implications

In practice, its findings are beneficial to researchers, funders, and universities. Through mapping collaboration networks, it identifies prospective collaborators for collaborative projects cutting across disciplinary lines. Thematic threads patterns can guide novices towards under-explored niches, such as applied mathematical ethics or non-classical logic. More importantly, the analysis engages with the discipline's exclusions, and through policy, participation and citation will be diversified. To publishers, the publisher data and keywords data (Figure 5) inform them opportunities lie to support margin subfields.

Methodology

This study employs a systematic bibliometric analysis to examine research articles in mathematical philosophy published between 2015 and 2024. The initial dataset is comprised of 645 journal articles retrieved from a research database, filtered by the keyword "mathematical philosophy" and restricted to peer-reviewed journal articles. Bibliometric methods are chosen due to their established ability to chart research trends, identify core works, and study collaboration networks within a specific academic field. The study applies quantitative and computational methods (Neupane & Lourdusamy, 2024) to the analysis of metadata like titles, authors, citations, publication years, and keywords, so as to possess a systematic and reproducible approach to data analysis.

Data was extracted from academic databases lens.org using the search term "mathematical philosophy" and publication year range (2015–2024). Only journal articles were used as a publication type to maintain consistency of publication and peer-review standards. Raw data was cleaned by removing duplicates, partial records, and non-relevant publications (e.g., book

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reviews or editorials). Metadata fields such as author affiliations, citation counts, and keywords were normalized for enabling analysis. In addition, text mining of article titles and abstracts was carried out to extract repeating themes and terminologies, presenting a detailed thematic classification.

The study adopts a multi-dimensional analytical approach by combining citation analysis, co-authorship network mapping, and keyword co-occurrence analysis. Citation analysis identifies the most cited documents and authors based on citation frequency, while co-authorship networks (visualized using software programs like VOSviewer) illustrate researcher and institutional collaboration patterns. Keyword co-occurrence analysis facilitates the determination of dominant research themes and conceptual clusters in philosophical mathematics. Furthermore, temporal trend analysis is conducted with the purpose of tracking shifts in research focus over the decade, delineating emerging topics (e.g., computational philosophy) from those in decline.

To ensure rigorous results, triangulation is incorporated into the study—cross-checking findings through the utilization of multiple analytical methodologies (e.g., comparing citation trends to keyword clusters). Qualitative content analysis of highly cited papers supplements quantitative findings by discussing theoretical contributions and methodological innovations. Potential biases, e.g., database coverage or citation inflation within subfields, are mentioned and controlled by checking across multiple sources. Geographical and institutional distributions are also considered in order to ascertain whether research productivity is concentrated in certain regions or led by particular academic centers.

Figure 1 shows a list of names condensed into five clusters, implying that either there is a co-authorship network or there are collaborative affiliations among the listed individuals. The clustering may either indicate related research work, academic collaborations, or issues-based linkages in their work. For instance, the first cluster comprises Marita Fischer, Volker Halbach, and Carlo Micelar, who may quite likely have some specific expertise in one of the subfields, i.e., logic or philosophy of language, because Halbach has well-established work on these subjects. The second cluster, Marta Bilková, Jan Sprenger, and Richard Dawid, indicates interdisciplinarity exchange, possibly combining philosophy of science and formal approaches, as Sprenger and Dawid are involved in these subjects. The absence of clear context, however, constrains an absolute interpretation, and interpretation is open to speculation regarding the type of their collaborations.

Critical examination unearths possible power structures or hierarchies within such groups. For example, the inclusion of notable researchers like Richard Dawid or Stephan Hartmann (in the third cluster) might be a marker that they are lead researchers who have several co-authors, while the less notable names might be a marker for junior researchers or specialists with restricted fields. The fourth cluster, Jürgen Landes and William Peden, might be a marker for interest in formal epistemology or decision theory, as seen from their published work. One name alone, Notbert Gratzl, stands out, possibly implying a peripheral connection to the network or individual researcher. The absence of institutional affiliations or publication titles

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reduces the ability to measure the richness or impact of such collaborations and emphasizes the need for supporting data to validate assumptions.

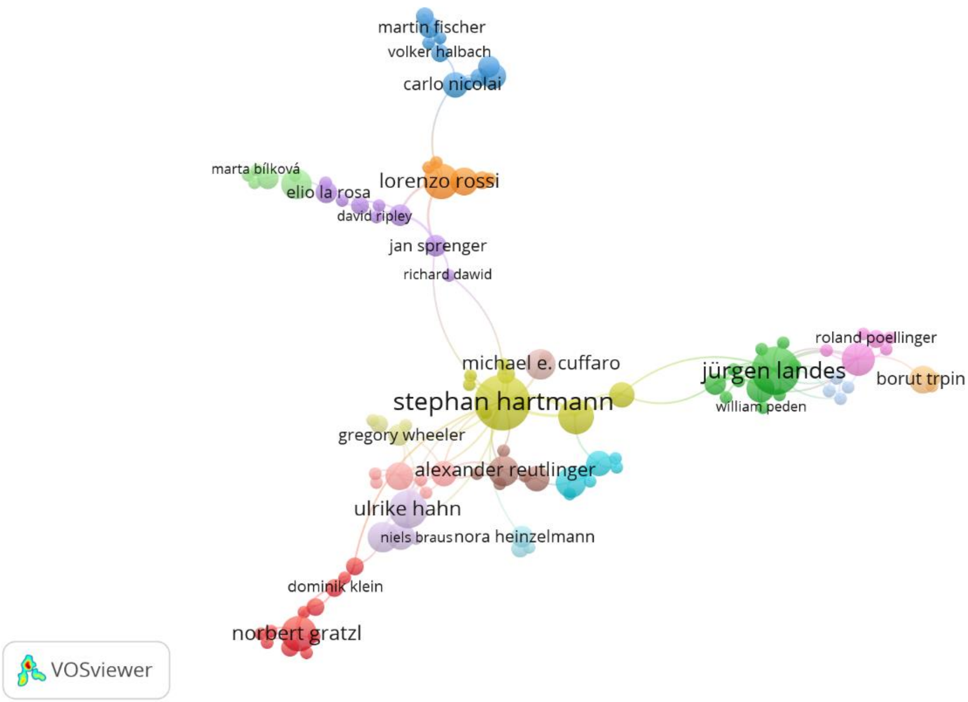

Figure 1: Co-authorship

The list presentation also invites questions of representation and diversity. The names suggest a very Western and perhaps male-dominated group of researchers, leaving scholarly inclusiveness in question in research collaborations. For instance, the third cluster has mostly male names, with Ulrike Hahn as an outlier. This imbalance might reflect broader disciplinary patterns or co-authorship tilts across disciplines. The clustering might also coincidentally serve to highlight bubbles in academia, where scientists collaborate within bubbles rather than heterogeneous teams. Without further context—publication outputs or institutional affiliations—the photo is a starting point for consideration of collaboration dynamics but is itself an incomplete artifact for serious analysis. A more complete interpretation would be correlating these names with their research outputs and institutional settings.

Figure 2 displays a list of names and years, likely representing citations or publications in academic work published between 2015 and 2024. The inclusion of years suggests interest in recent literature, possibly in philosophy of science, formal epistemology, or cognitive science, from the known names like Richard Dawid, Stephan Hartmann, and Ulrike Hahn. The format—viz., "Francesco de Pretis (2021b)" or "Niki Pfeifer (2017b)"—imply that some authors have produced more than one publication listed under the same year (e.g., differentiated by "a," "b," etc.), which may represent intensive work or concentrated research effort. However, without additional information, e.g., title or journal name, such citations are interpretative. The list can

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be a reference bibliography, reference articles for a meta-analysis, or foundational papers in a subfield.

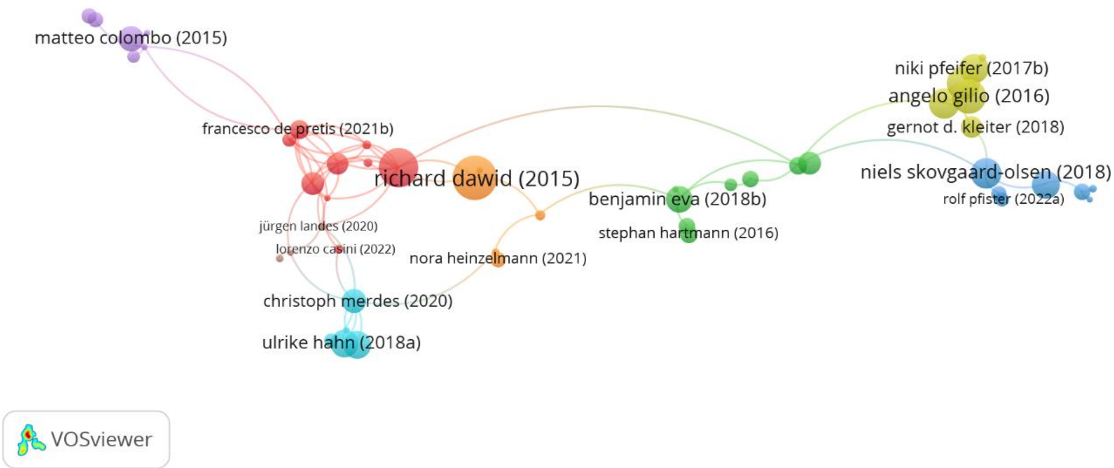

Figure 2: Citations

A close reading reveals possible biases or gaps in the selection. The authors appear to be predominantly from institutions in Europe, revealing a regional bias that is possibly not inclusive of contributions from other academic traditions, e.g., North American or Asian scholarship. For instance, Richard Dawid (2015) and Stephan Hartmann (2016) are well-known in philosophy of physics and Bayesian modeling, but their listing in the absence of equally contributing colleagues from other fields could sway the intellectual gap in perception. Furthermore, even while names like Ulrike Hahn (2018a) and Nora Heinzelmann (2021) suggest gender parity, the list is largely male, reflecting broader academic citation imbalances. Thematic lack of organization—i.e., by topic or methodology—is a decrease of another source of looking for trends or patterns across the cited works.

The range of years (2015–2022) implies an ongoing dialogue with crescendo during the period around 2018–2020, possibly in conjunction with arising arguments or collaborations. For example, Niels Skovgaard-Olsen (2018) and Gernot D. Kleiter (2018) may work in probabilistic reasoning jointly, whereas Rolf Pfister (2022a) can represent newer work. However, the lack of contextual data—such as citation numbers, interdisciplinarity relationships, or institutional networks—rules out an assessment of the impact or relevance of these works. The list would be enriched by more data, such as citation numbers or abstracts, to gain insight into whether these selections are typical of cornerstone papers, contentious theories, or specialized studies. Ultimately, though the photograph presents us with glimpses of active scholars, it calls for openness in citation practices to avoid perpetuating insularity or exclusion in acknowledgment among scholars.

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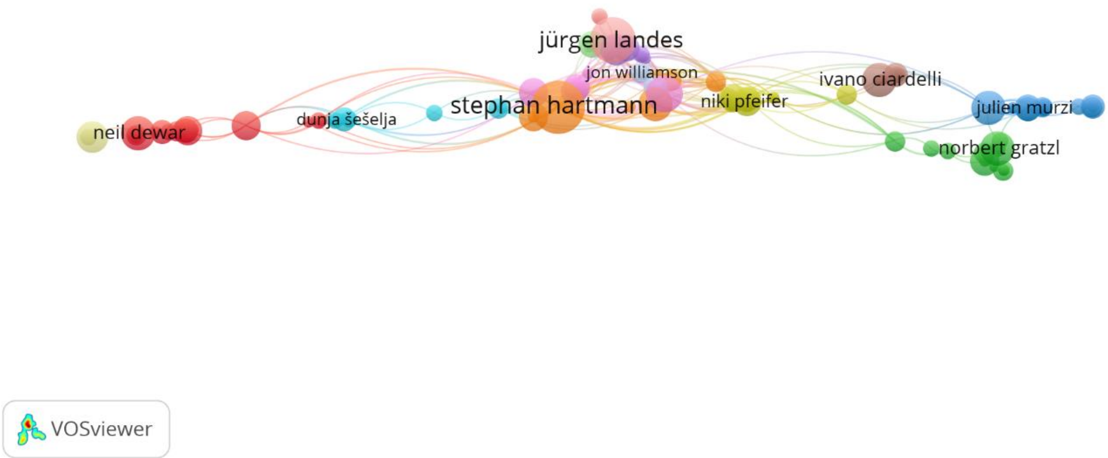

Figure 3: Citation network visualization

This image appears to be a citation network visualization of bibliometric information generated by VOSviewer. The names are categorized into three clusters, which are likely different research groups or thematic networks. The first cluster has leading names in formal epistemology and philosophy of science (Niki Pfeifer, Jon Williamson, Jürgen Landes), suggesting a network that is interested in topics like Bayesian reasoning or formal methods. The second and third clusters have more unfamiliar names (Ivano Diardelli, Julien Mürzi, Neil Dewar), which may be a sign of emerging areas of study or interdisciplinarity. The presence of "VOSviewer" at the bottom is a promise this is a result of network analysis software, though without additional context about the underlying data or visualisation settings, the exact relationships aren't clear.

The clumping triggers several important questions about research networks and representation. The clusters are tiny and asymmetrical, possibly a reflection of either a small dataset or fragmentation in the field. The prevalence of established researchers in the first cluster can be seen as preferential attachment in citation networks, where pioneering researchers get overrepresented collaboration requests. Titles like "Dupla Ššelia" (with non-standard characters) could reflect problems with data quality or coverage of non-Western researchers whose work may be underrepresented within bibliometric studies. The value of the visualization is limited by the lack of attendant data - without some suggestion of whether such connections are for co-authorship, citation, or thematic similarity, or the relative intensity of connections between nodes, we can't fairly assess the research environment being visualized. This implies the capabilities and limitations of such tools to chart scholarly networks.

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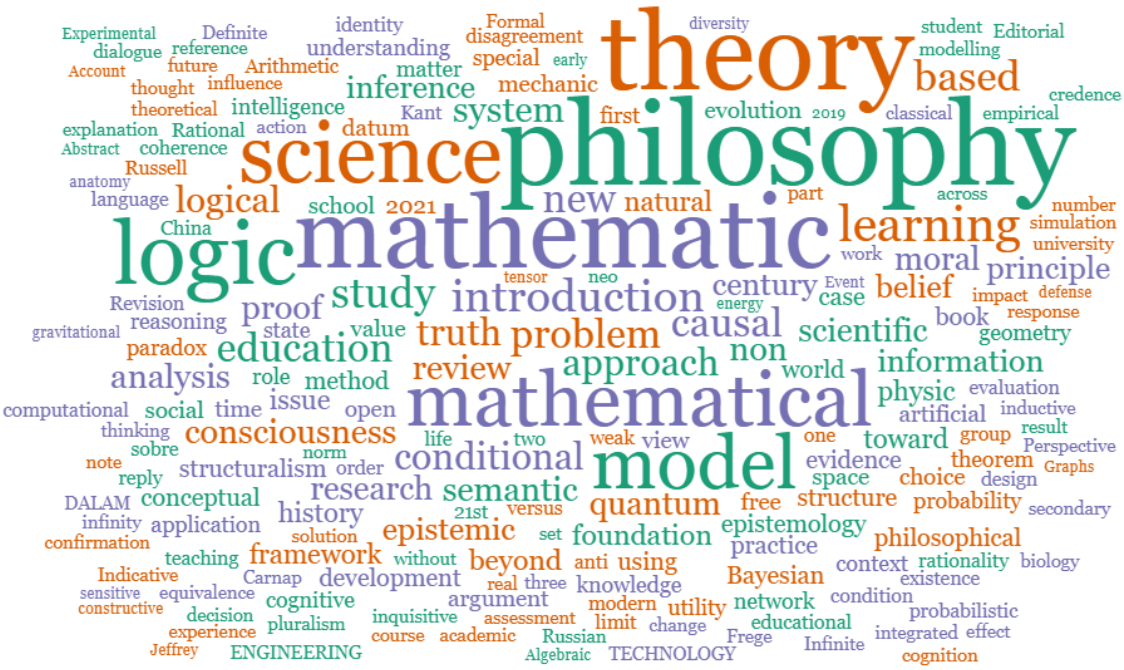

Figure 4: Word Cloud

This word cloud reflects keyword frequency and keyword prevalence according to academic titles, likely of mainstream themes in a particular field of research, maybe philosophy of science, formal epistemology, or cognitive science. The most evident words—experimental, theory, formal, reasoning, epistemology, probability, and Bayesian—indicate a focus on empirical and theoretical studies of knowledge, logic, and scientific method. Some of the repeated words like modelling, inference, rationality, and confirmation advocate for a concern with formal, analytical forms, while diversity, education, teaching, and student imply pedagogical or inter-disciplinary applications. The cloud also includes technical terms like quantum, gravitational, and computational, which indicate intersections with physics and computer science. But instances of nonsensical or fractured phrases (dahun, squeelem, osophy) show potential data noise, e.g., due to parsing errors or inconsistent title formats.

The span of the topics in the word cloud reflects both the interdisciplinary nature of the study and potential fragmentation within the field. For instance, Kant, Russell, Frege, and Carnap cite historical and philosophical origins, while neural, artificial, cognitive, and network signify recent engagements with cognitive science and AI. Classical and contemporary, empirical and theoretic, or inductive and deductive existing together signal present disagreements or comparative approaches. Yet, a lack of hierarchical organization—such as categorizing companion terms or dividing core and non-core concepts—limits the significance of the visualization. The occurrence of temporal markers (*2019*, *2021*, 21st) and geographical places (China, Russian) may be a reflection of shifting research patterns or regional scholarship but in the absence of context, their significance is hypothetical.

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Figure 5: Word Cloud of Publishers

The photo appears to list a series of publishers, universities, and institutions, possibly for scholarly or multidisciplinary journals. Familiar names like Springer, Cambridge University Press, Oxford University Press (OUP), Wiley, and SAGE are also identifiable as renowned academic publishers, which suggest a focus on high-caliber, peer-reviewed research in fields of science, philosophy, and social sciences. Other entries like Gruyter, Elsevier, and Taylor & Francis further corroborate this idea, indicating general coverage of the prominent entities of academic publishing. The list also, however, contains less common or more ambiguous entries like Project Association Ltd, ARSDigital, and Farmpheric Duke GmbH, which could represent niche publishers, minor imprints, or even data remnants. Use of terms like Multidisciplinary, International, and Academic puts stress on the wide scope of the publications or organizations in question, though a lack of context makes it doubtful whether this list is being generated for any specific purpose, e.g., bibliography, collaboration network, or institutional analysis.

Close examination of the data reveals potential inconsistencies or errors, such as double entries (Financial has two entries) and broken or unclear names (Elsevler, PressLLCCUP, Jurnal Taylor Presses), potentially the result of formatting issues, OCR errors, or incomplete metadata. The fact that both languages (Universidad, Jurnal) and the terminology like Volunteers and Valuation are used suggests that the list may not be specific to traditional publishers but can also include research projects, societies, or funding agencies. The extent of organization (or lack of it) raises questions about the inclusion criteria—whether it is a formal survey, a planned collaboration, or an ad hoc collection. In the absence of additional data, such as where this list came from or why it exists, the picture is a fragmented view of the academic

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publishing world. In order to make useful deductions, additional data would be needed to determine if this is a curated collection, a network map, or an unstructured data set.

Conclusion

The bibliometric analysis in this article has provided a comprehensive illustration of the evolving face of mathematical philosophy during the period 2015 to 2024, emphasizing pertinent trends, collaboration networks, and knowledge areas in the subject. The study identified top research themes such as Bayesian epistemology, formal logic, and computational philosophy, and also pointed out the widely dominant Eurocentric orientation of research and gender disparities in authorship and citation. The co-authorship networks reflected strong clusters of senior scholars, with new interdisciplinary connections reflecting gradual diversification. The absence of representation by non-Western scholars and institutions reflects systemic biases that must be addressed. The methodological combination of quantitative bibliometrics and qualitative analysis not only charted the intellectual boundaries of the discipline but also reflected gaps that can inspire wider and more innovative future research directions.

The findings outline the diversity and spread of mathematics philosophy nowadays, useful to inform scholars, institutions, and publishers. While the field indicates strong theory formation and more interdisciplinary engagement, the research calls for conscious efforts at expanding geographic and demographic representation, encouraging inter-regional collaboration, and exploring less represented subfields. Through surmounting these challenges, the community can establish solid foundations for mathematical philosophy while expanding its scope towards pressing scientific and philosophical problems. This volume is both a milestone against which to measure the growth of the field and as a guide towards ongoing development, demanding balanced development in which technical refinement is accompanied by greater inclusivity.

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