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Globalizing Physics: One Hundred Years of the International Union of Pure and Applied Physics. An Introductory Essay / Lalli, R., Navarro, J. - In: Globalizing Physics: One Hundred Years of the International Union of Pure and Applied Physics / Lalli R., Navarro J.. - [s.l] : Oxford University Press, 2024. - ISBN 0198878680. - pp. 1-16 [10.1093/oso/9780198878681.003.0001]

Availability:
This version is available at: 11583/2992867 since: 2024-09-29T04:54:26Z

Publisher:
Oxford University Press

Published
DOI:10.1093/oso/9780198878681.003.0001

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17 November 2026

Introduction

Globalizing Physics: One Hundred Years of the International Union of Pure and Applied Physics. An Introductory Essay

Roberto Lalli and Jaume Navarro

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Physics played a major role throughout the 20th century in both wartime and peacetime. It underwent a major conceptual reconfiguration at the turn of the century with massive and long-lasting cultural and philosophical impacts. After World War II, physics came to be perceived, especially because of the atom bomb project, as the discipline whose development was decisive to national security, hence shaping the politics of the Cold War. Authoritative physicists became part of national Advisory Boards, thus playing crucial roles in the configuration of national and foreign policies, as well as acquiring enormous scientific prestige internationally.

Given the relevance of physics in contemporary history, it is perhaps surprising that the scholarly literature overlooks the history of the most authoritative international organization devoted to physics that globally unites professionals of this discipline: the International Union of Pure and Applied Physics (IUPAP). As of 2022, the year of IUPAP's centenary, the only work exploring its past is a short booklet issued for the 70th anniversary of the Union and listing major events and figures. Former officers of this international organization have written short articles on its history too, but none extensive enough to shed light on its origins and evolution.[1] This volume therefore fills an important gap in our knowledge of the Union's history. It does so through contributions addressing both general developments and specific cases that highlight key aspects of IUPAP's role in both physics and international affairs. All the contributions display how the Union pursued its mission in a changing historical context, shaped by a variety of external social and political factors.

IUPAP's current officials played a key role in the project leading to this volume as, while preparing for the centenary celebrations, they promoted the digitization of its entire institutional archive so that the scholars involved in the project could share and analyze these historical documents.[2] In COVID times, this proved invaluable since contributors to the collection worked in institutions located in four different continents and, due to the pandemic, could not travel to archives either. IUPAP also

[1] *IUPAP 1922–1992*, available at https://archive2.iupap.org/wp-content/uploads/2013/04/history.pdf; Pierre Fleury, "The International Union of Pure and Applied Physics from 1923 to 1972," in *Physics 50 Years Later: [Papers] as Presented to the XIV General Assembly of the International Union of Pure and Applied Physics on the Occasion of the Union's Fiftieth Anniversary, September 1972* (Washington, DC: National Academies Press, 1973), 3–12.

[2] Available at https://iupap.org/centennial/iupap-100-project/.

Roberto Lalli and Jaume Navarro, *Globalizing Physics*. In: *Globalizing Physics*. Edited by: Roberto Lalli and Jaume Navarro, Oxford University Press. © Oxford University Press (2024). DOI: 10.1093/oso/9780198878681.003.0001

co-financed, together with the Donostia International Physics Center (DIPC), the hybrid workshop held in San Sebastian in October 2022 where, at the end of the pandemic, these scholars met to discuss the drafts of their original articles. IUPAP's support was thus immensely important, though not alone in supporting the project. The combined efforts of the newly established Inter-Union (IUHPST/IUPAP) Commission on the History and Philosophy of Physics (IUCHPP), and the International Union of History and Philosophy of Science and Technology (IUHPST)/Division of History of Science and Technology (DHST) Commission on Science, Technology and Diplomacy (STAND) further contributed to the completion of this project.[3]

This volume charts the history of IUPAP as a crucial case study of the institutionalization of international science through the setting up of scientific unions and its umbrella organization, the International Council of Scientific Unions (ICSU). Originally conceived as the International Research Council (IRC), in 1931 it was re-named as ICSU and has since then been the main forum to coordinate international activities of various scientific unions.[4] Volumes written on the history of ICSU and its unions have been a valuable reference, but our approach has been considerably different. Such historical studies are monographs that seek to provide an overall perspective of the activities of the unions. Often written by scientists and officers, they usually offer a first-hand perspective of the organizations in which they had been personally involved.[5] Other monographs written by professional historians still offer synthetic narratives of the inner workings of scientific unions.[6] And some projects assembling both scientists and historians have provided interesting collections devoted to a variety of aspects of some unions' institutional history.[7]

This edited collection adds a historical analysis to these views that situates the history of IUPAP in the broader literature on science and international relations, also building on the bourgeoning literature on transnational historiography of science and technology.[8] In this respect, the volume also draws on a recent edited volume

[3] Available at https://www.iuchpp.org/; https://sciencediplomacyhistory.org/.

[4] For brevity's sake, in this introductory essay we will refer to ICSU as the umbrella organization, whatever the historical period under discussion. Since 2018, ICSU has merged with the International Social Science Council to form the International Council for Science (ICS), available at https://council.science/.

[5] Adriaan Blaauw, *History of the IAU: The Birth and First Half-Century of the International Astronomical Union* (Dordrecht; Boston: Kluwer Academic Publishers, 1994); Roger Fennell, *History of IUPAC, 1919–1987* (Oxford; Boston: Blackwell Science Ltd, 1994); Frank Greenaway, *Science International: A History of the International Council of Scientific Unions* (Cambridge, [England]; New York: Cambridge University Press, 1996); Olli Lehto, *Mathematics without Borders: A History of the International Mathematical Union* (New York: Springer, 1998).

[6] Johannes Andersen, David Baneke, and Claus Madsen, *The International Astronomical Union: Uniting the Community for 100 Years* (Cham: Springer International Publishing, 2019); Norbert Schappacher, *Framing Global Mathematics: The International Mathematical Union between Theorems and Politics* (Cham: Springer International Publishing, 2022).

[7] Christiaan Sterken, John Hearnshaw, and David Valls-Gabaud, eds., *Under One Sky: The IAU Centenary Symposium* (Cambridge, UK: Cambridge University Press, 2019). Brigitte Van Tiggelen, ed., "Special IUPAC100," Special issue. *Chemistry International* 41 (2019).

[8] On the transnational historiography of science and technology, see John Krige and Kai-Henrik Barth, eds., "Global Power Knowledge: Science and Technology in International Affairs," Special issue, *Osiris* 21 (2006); Simone Turchetti, Néstor Herran, and Soraya Boudia, "Introduction: Have We Ever Been 'Transnational'? Towards a History of Science across and beyond Borders," *The British Journal for the History of Science* 45, no. 3 (2012): 319–36; Jeroen van Dongen, Friso Hoeneveld, and Abel Streefland, eds., *Cold War Science and the Transatlantic Circulation of Knowledge* (Leiden; Boston: Brill, 2015); John Krige, ed., *How*

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focusing on the relationship between science and diplomacy in the context of the International Astronomical Union (IAU).[9] All these new narratives shed light on the important role that scientific unions have played not just within the scientific world, but also in addressing, as a sort of "parallel" or track-II diplomatic forum, the relations between states and international political organizations globally.[10]

In 1963, a key figure in IUPAP's history, the Canadian physicist and IUPAP Secretary General Larkin Kerwin, stated that "the Union's purpose is to foster international physics meetings, more rapid dissemination of information and the establishment of international standards, units and nomenclature;" but crucially added that "[i]ts *unofficial* goal is to make a contribution to general international understanding."[11] As our research moved on, we realized that this science diplomacy component was a major driving factor in the development of the Union.

Thus, our approach in writing the history of IUPAP has been different and more ambitious than previous historical accounts of international unions. In addition to in-depth analyses of case studies and themes, some contributors (including the two co-editors) carried out the task of writing articles that address the historical unfolding of the institution in more general and synthetic terms, thus placing specific themes and analyses into a long-term narrative. Overall, we collectively aimed at interpreting the history of IUPAP as a case study to investigate the complex dynamic relations between science and international politics in its historical unfolding and global repercussions. Contributors have thus focused on critical questions such as the roles IUPAP played in the scientific and political arenas (and the interaction thereof); or the Union's dependency on broader historical transformations connected to globalization. The following synthetically recalls some of the general themes that have emerged in addressing these questions.

What Kind of Institution is IUPAP?

IUPAP was part of a network of scientific organizations that, strictly speaking, operated outside the sphere of governmental affairs but that, in fact, integrated in the activities and policies of governments and multilateral organizations. In examining these operations, IUPAP reveals itself as an organization practicing what we call today science diplomacy.

While many international scientific institutions have attracted the interest of historians of science, most accounts focus on project-oriented organizations, often operating in the European context. United Nations Educational, Scientific and Cultural Organization (UNESCO) has also received overwhelming attention as the

Knowledge Moves. Writing the Transnational History of Science and Technology (Chicago: University of Chicago Press, 2019); John Krige, *Knowledge Flows in a Global Age: A Transnational Approach* (Chicago: University of Chicago Press, 2022).

[9] Thierry Montmerle and Danielle Fauque, eds., *Astronomers as Diplomats: When the IAU Builds Bridges Between Nations* (Cham: Springer International Publishing, 2022).

[10] For the concept of Track II diplomacy, see Peter L. Jones, *Track Two Diplomacy in Theory and Practice* (Stanford, California: Stanford University Press, 2015).

[11] Larkin Kerwin, "The International Union of Pure and Applied Physics," *Physics Today* 22, no. 5 (1969): 53–5, on 53.

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main intergovernmental body devoted to the promotion of scientific and cultural exchanges (as well as education).[12] Over the last decade, interest in the history of international scientific institutions has grown, catering for a broader coverage, and offering readings that have also challenged the conventional understanding of the Cold War as a bipolar conflict through analyses of the global impacts of science and technology.[13] The emergence of science diplomacy as a key aspect in international affairs in both scientific and political circles has further increased historians' interest in the activities and functions of international organizations.[14] The parallel historical reflection on the notions of scientific internationalism and universalism has shed light on the institutions that negotiated, defined, and operationalized these notions in the international arena.[15] Finally, the increasing interest on transnational networks in connection with the growth of application of social network analysis as a methodological tool, has also led to reconsidering international scientific institutions as primary objects of investigation.[16]

One key issue is whether international scientific institutions depend on the official involvement of governments. The 1945 United Nations (UN) Charter sanctioned a

[12] James Patrick Sewell, *UNESCO and World Politics: Engaging in International Relations* (Princeton, NJ: Princeton University Press, 1975); Clare Wells, *The UN, UNESCO and the Politics of Knowledge* (London: Palgrave Macmillan UK, 1987); Jean-Jacques Renoliet, *L'Unesco oubliée: la Société des Nations et la coopération intellectuelle, 1919–1946* (Paris: Publications de la Sorbonne, 1999); Aant Elzinga, "UNESCO and the Politics of International Cooperation in the Realm of Science," in *Internationalism and Science*, eds., Aant Elzinga and Catharina Landstrom (London: Taylor Graham, 1996), 89–131; Daniel Laqua, "Transnational Intellectual Cooperation, the League of Nations, and the Problem of Order," *Journal of Global History* 6, no. 2 (2011): 223–47; Corinne A. Pernet, "Twists, Turns and Dead Alleys: The League of Nations and Intellectual Cooperation in Times of War," *Journal of Modern European History* 12, no. 3 (2014): 342–58.

[13] See references in note 8. For new perspectives on the global Cold War, see, Melvyn P. Leffler and Odd Arne Westad, eds., *The Cambridge History of the Cold War*, 3 vols (Cambridge: Cambridge University Press, 2010).

[14] Recent journals' special issues showing the increasing interest of science historians in science diplomacy are Simone Turchetti and Giulia Rispoli, eds., "Science Diplomacy," Special issue, *Historical Studies in the Natural Sciences* 50, no. 4 (2020); Lif. L. Jacobsen and Doubravka Olšáková, eds., "Diplomats in Science Diplomacy: Promoting Scientific and Technological Collaboration in International Relations," Special issue, *Berichte zur Wissenschafts-geschichte* 43, no. 4 (2020); Roberto Lalli and Matthew Adamson, eds., "Global Perspectives on Science Diplomacy," Special issue. *Centaurus* 63, no. 1 (2021); Kenji Ito and Maria Rentetzi, eds., "Nuclear Diplomacies," Special issue. *History and Technology* 37, no. 1 (2021); Maria Rentetzi and Kenji Ito, eds., "The Material Culture and Politics of Artifacts in Nuclear Diplomacy," Special issue, *Centaurus* 63, no. 2 (2021); Simone Turchetti and Matthew Adamson, eds., "Science, Technology and Visual Diplomacy," Special issue, *British Journal for the History of Science* 56, no. 2 (2023).

[15] Elisabeth Crawford et al., eds., *The Nationalization and Denationalization of the Sciences*, Sociology of the Sciences A Yearbook 16 (Netherlands: Springer, 1993); Aant Elzinga and Catharina Landstrom, eds., *Internationalism and Science* (London: Taylor Graham, 1996); Simone Turchetti et al., "On Thick Ice: Scientific Internationalism and Antarctic Affairs, 1957–1980," *History and Technology* 24, no. 4 (2008): 351–76; Geert J. Somsen, "A History of Universalism: Conceptions of the Internationality of Science from the Enlightenment to the Cold War," *Minerva* 46, no. 3 (2008): 361–79; Robert Fox, *Science without Frontiers: Cosmopolitanism and National Interests in the World of Learning, 1870–1940* (Corvallis, OR: Oregon State University Press, 2016); Waqar H. Zaidi, *Technological Internationalism and World Order* (Cambridge: Cambridge University Press, 2021).

[16] See, e.g., Christine von Oertzen, *Science, Gender, and Internationalism: Women's Academic Networks, 1917–1955* (New York, NY: Palgrave Macmillan, 2014). On historical analyses of international scientific organizations explicitly based on social network analysis, see Roberto Lalli, *Building the General Relativity and Gravitation Community During the Cold War* (Cham: Springer International Publishing, 2017); Martin Grandjean and Marco H. D. van Leeuwen, *Mapping Internationalism: Congresses and Organisations in the Nineteenth and Twentieth Centuries* (London: Bloomsbury, 2019).

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distinction between intergovernmental and non-governmental organizations (IGOs and NGOs) also setting general principles for their operations.[17] Works charting the history of scientific IGOs seem prevalent when compared to those looking into that of scientific NGOs, but it is important to emphasize that their evolution is marked by networking activities enmeshing one group of organizations into the other and establishing ties that complicate any effort to easily define the constellation of international scientific organizations departing from this distinction.[18] So, like all other unions and ICSU itself, IUPAP is categorized as an NGO, even if over the post-war period it was lavishly funded through the intergovernmental UNESCO. Moreover, the legalistic characterization of IUPAP as an NGO works mainly from 1945, since the status of the Union as an international body was by and large undefined in previous decades.[19]

Historians and sociologists of science interested in international scientific institutions have put forward alternative taxonomies of such institutions partly in an effort to overcome the theoretical impasse that a strict distinction between scientific NGOs and IGOs outlines, and have looked into their modes of operation in scientific internationalism instead. Crawford et al., for instance, distinguish between *spontaneous* and *bureaucratic* institutions.[20] Spontaneous are "institutions motivated by the interests of individual scientists who draw on national resources to hold world congresses, committees, coordinate projects," while the bureaucratic institutions are organizations whose "cooperative schemes are [...] outgrowths of government programs and therefore strongly influenced by national interests."[21] The authors consider scientific unions and ICSU as aligned with the former model, while UNESCO exemplifies the latter. Aant Elzinga, similarly, differentiates between *autoletic* and *heteroletic* organizations, the former serving "science as an end in its own right" and the latter supporting "transnational scientific cooperation on extra-scientific grounds."[22]

Although IUPAP legally identifies as an NGO and should fit the definition of a spontaneous or autoletic mode of operation, various chapters in this volume show that this was hardly ever the case. In most part of the interwar period, all unions of the ICSU family were the embodiment of a political project extending World War I military alliances into post-war scientific cooperation. The institutionalized boycott of German physics discussed in the chapters by Fauque and Fox and Navarro, demonstrates that during the 1920s and 1930s IUPAP was fully implicated in the geopolitical dynamics of allied governments. Similarly, most chapters dealing with the history of IUPAP in the post-World War II period explicitly frame the Union as a venue for science diplomacy exercises, which had implications for the interactions between

[17] Kerstin Martens, *NGOs and the United Nations: Institutionalization, Professionalization and Adaptation* (Basingstoke [England]: Palgrave Macmillan, 2005).

[18] For recent historical studies of IGOs see, e.g., Simone Turchetti, *Greening the Alliance: The Diplomacy of NATO's Science and Environmental Initiatives* (Chicago; London: The University of Chicago Press, 2019); Elisabeth Roehrlich, *Inspectors for Peace: A History of the International Atomic Energy Agency* (Baltimore: Johns Hopkins University Press, 2022).

[19] Martens, *NGOs and the United Nations*.

[20] Elisabeth Crawford, Terry Shinn, and Sverker Sörlin, "The Nationalization and Denationalization of the Sciences: An Introductory Essay," in *Denationalizing Science*, ed. Elisabeth Crawford, Terry Shinn, and Sverker Sörlin (Netherlands: Springer, 1993), 1–42.

[21] Crawford et al. "Nationalization and Denationalization," 23–4.

[22] Aant Elzinga, "Modes of Internationalism," in *In Internationalism and Science*, ed. Aant Elzinga and Catharina Landstrom (London: Taylor Graham, 1996), 3–20.

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individual governments, multilateral organizations, and in some cases,—e.g., the German Democratic Republic (GDR), the People's Republic of China (PRC), and the Republic of China (ROC) in Taiwan—even for the international recognition of these countries.

As mentioned previously, science diplomacy has recently emerged as a powerful buzzword at the intersection of studies on science, science policy, and international relations.[23] Historians have contributed to explore its past dimensions hence providing new analytical frameworks and key case studies.[24] This new literature (partly elaborated in connection with initiatives of the STAND Commission) has contributed to appraise the conventional understanding of science diplomacy as an inevitably beneficial tool in international relations. This idealized view, as Science and Technology Studies (STS) scholars Charlotte Rungius and Tim Flink contend, reiterates a simplistic understanding of science as inherently neutral and apolitical.[25] Many chapters in this volume capture historically contextualized science diplomacy exercises in which IUPAP was involved or featured as main actor, often explicitly using science diplomacy as an analytical framework.

Silva Neto and Kojevnikov show, for instance, that the Soviet entrance in IUPAP marked an appraisal of the notion of socialist internationalism and, contingently, of Soviet participation in international organizations. While membership to socialist multilateral organizations continued to be a key asset for the USSR, Soviet policymakers now embraced a parallel policy of acceptance of organizations uniting representation from both blocs. This recognition transformed international scientific cooperation in a device of Cold War détente, implicitly reiterating the stance of peaceful co-existence of communist and capitalist blocs. Within this co-existence, as Hof's chapter shows, new dynamics of competition and cooperation emerged, as evidenced by the setting up (in parallel with the USSR joining IUPAP) of a commission on high-energy physics. Hof argues that it was the rhetoric of "purity"—implemented by labeling high-energy particle physics as a pure research branch in opposition to applied nuclear physics—that enabled this cooperation.

[23] Daryl Copeland, "Science Diplomacy," in *The SAGE Handbook of Diplomacy*, ed. Costas M. Constantinou, Pauline Kerr, and Paul Sharp (SAGE, 2016), 628–41; Tim Flink and Ulrich Schreiterer, "Science Diplomacy at the Intersection of S&T Policies and Foreign Affairs: Toward a Typology of National Approaches," *Science and Public Policy* 37, no. 9 (2010): 665–77; Pierre-Bruno Ruffini, *Science and Diplomacy: A New Dimension of International Relations* (New York, NY: Springer Berlin Heidelberg, 2017).

[24] For historical analytical perspectives, see Simone Turchetti et al., "Introduction: Just Needham to Nixon? On Writing the History of 'Science Diplomacy,'" *Historical Studies in the Natural Sciences* 50, no. 4 (2020): 323–39; Lif Lund Jacobsen and Doubravka Olšáková, "Diplomats in Science Diplomacy: Promoting Scientific and Technological Collaboration in International Relations," *Berichte Zur Wissenschaftsgeschichte* 43, no. 4 (2020): 465–72; Matthew Adamson and Roberto Lalli, "Global Perspectives on Science Diplomacy: Exploring the Diplomacy-Knowledge Nexus in Contemporary Histories of Science," *Centaurus* 63, no. 1 (2021): 1–16; Simone Turchetti and Matthew Adamson, "Introduction: Power to the Image! Science, Technology and Visual Diplomacy," *The British Journal for the History of Science* 56, no. 2 (2023): 135–46. For the case of nuclear diplomacy, see Kenji Ito and Maria Rentetzi, "The Co-Production of Nuclear Science and Diplomacy: Towards a Transnational Understanding of Nuclear Things," *History and Technology* 37, no. 1 (2021): 4–20;Maria Rentetzi and Kenji Ito, "The Material Culture and Politics of Artifacts in Nuclear Diplomacy," *Centaurus* 63, no. 2 (2021): 233–43.

[25] Charlotte Rungius and Tim Flink, "Romancing Science for Global Solutions: On Narratives and Interpretative Schemas of Science Diplomacy," *Humanities and Social Sciences Communications* 7, no. 1 (2020): 1–10.

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Science diplomacy features preeminently in the chapters discussing long-standing issues regarding membership in IUPAP, mainly because of the controversies surrounding acceptance of national committees from the GDR (discussed in the chapter by Olšáková), and those from the PRC and the ROC (analyzed in the chapter by Hu, Liu, and Yin). The participation of these committees evolved into tense diplomatic issues since it happened at the time when the GDR and the PRC had no official recognition in the West as independent countries. Both ICSU and IUPAP attempted to manage the ensuing controversy by staying away from explicitly political claims and deliberating that a union's acceptation of a national committee had no implication for the international recognition of the respective states or governments. Yet, since this recognition was highly contested in the Cold War climate, it transformed IUPAP into a parallel diplomatic arena adjacent the UN forum where the debate on their status was articulated. These requests of admission into IUPAP arrived all within a few months in the period 1958–59 and implicated even more actors, such as for instance the members of the West German National Physics Committee unwilling to accept another German committee. US Department of State officials were deeply involved too (and anxious), given their support for ROC's recognition and the parallel opposition to that of the PRC which they avowedly opposed (as argued by Hu, Liu, and Yin).

Even when these controversies ended, they had ramifications in another international conflict between IUPAP and the North Atlantic Treaty Organization (NATO) over the banning to travel of individual scientists from East Germany to NATO countries. As argued in Turchetti's chapter, the tensions produced by the ban were formative of IUPAP as a science diplomacy organization in that the strong position taken by its President, the Indian physicist Homi Bhabha, marked the beginning of a more visible presence of the Union, globally, in the political arena through campaigning for the free circulation of scientists. In turn, this transformation defined one of the primary goals of IUPAP and ICSU in later years as a specific pledge in favor of East German scientists turned into a global one for any world scientist who could not travel to international conferences.

This science diplomacy framework also helps to capture many other instances when IUPAP's activities had implications for state affairs, from Latin America to East Asia, such as in the case of the organization of the International Conference of Theoretical Physics in 1953 Japan (as discussed by Ito), and that of the Soviet-Italian physicist Gleb Wataghin (portrayed in Da Silva's chapter). All these analyses challenge the simplistic division of international collaborative work into IGOs and NGOs, and uncover the existence of an extensive network comprising both. They also reveal IUPAP as a decisive cluster of this global network.

In turn, they lend further support to the view that over the last one hundred years IUPAP was more than just an organization devoted to assembling physicists internationally for the sake of advancing physics. Indeed, they display that IUPAP, as an international organization, built bridges (and at times tensions) between governments, regardless of its institutional status as an NGO. Globalization was a factor in this transformation. There is a bourgeoning literature in international relations studies explaining the deep impact of non-state actors—defined as actors whose actions

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are not necessarily officially endorsed by Governments—in international affairs.[26] Non-governmental institutions are among those non-state actors that transnational historians have recently considered as key in influencing world affairs especially with the weakening power of traditional state-to-state interactions and the opening of a new global sphere of decision-making mediated by multilateral organizations.[27] Science studies scholars have contributed to the effort to chart this transformation by arguing for the co-production of global scientific knowledge and global political order.[28]

To sum up, we have studied IUPAP by breaking up conventional separations distinctive of international scientific organizations. Consequently, we contend that it is impossible to understand the Union as purely spontaneous or autoletic. Indeed, we show that the history of IUPAP displays a constant oscillation between autoletic and heteroletic modes of operation, depending on the political contexts that shaped these relations and the function of science in wider international issues debated at the time. As Lalli argues, IUPAP should rather be understood as a *hybrid* science diplomacy agent, constantly balancing between governmental and non-governmental interactions. In what follows, we show how this new approach assists in better understanding IUPAP's scientific attainments over the one hundred years of its existence.

IUPAP in the Scientific Realm

Historical theories of knowledge evolution see scientific institutions as regulative infrastructures that allow codifying, embodying, enabling, and transmitting knowledge across human society.[29] The dimension of internationality complicates this picture because the kind of social structure related to such institutions necessarily require to take into consideration the dimension of international politics. Crawford et al. have argued that the primary function of international scientific institutions has been to negotiate and define standards at the international level, at least in the period between the second half of the 19th century and the first decades of the 20th century. In their view, these standardization efforts acted at three levels: the pursuit of cognitive homogeneity within disciplines or emerging research areas, the establishment of shared communication standards within the largest scientific or disciplinary communities, and negotiations about technical standards often related to commercial needs in an increasingly global market.[30]

[26] Thomas Risse-Kappen, ed., *Bringing Transnational Relations Back In: Non-State Actors, Domestic Structures and International Institutions* (Cambridge: Cambridge University Press, 1995).

[27] Akira Iriye, *Global Community: The Role of International Organizations in the Making of the Contemporary World* (Berkeley: University of California Press, 2002).

[28] Sheila Jasanoff, *The Idiom of Co-Production, States of Knowledge* (Routledge, 2004), https://doi.org/10.4324/9780203413845-6; John Krige, "Hybrid Knowledge: The Transnational Co-Production of the Gas Centrifuge for Uranium Enrichment in the 1960s," *The British Journal for the History of Science* 45, no. 3 (2012): 337–57; Ito and Rentetzi, "The Co-Production of Nuclear Science and Diplomacy." For employment of science diplomacy as a framework to interpret non-governmental international scientific organizations, see Roberto Lalli, "Crafting Europe from CERN to Dubna: Physics as Diplomacy in the Foundation of the European Physical Society," *Centaurus* 63, no. 1 (2021): 103–31.

[29] Jürgen Renn, *The Evolution of Knowledge* (Princeton: Princeton University Press, 2020).

[30] Crawford, Shinn, and Sörlin, "The Nationalization and Denationalization of the Sciences."

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Our investigations into IUPAP's history further complicates this picture. Standardization, at the cognitive and communication levels, was indeed one of the Union's primary goals since its establishment in 1922, as demonstrated especially by the setting up of its Working Commission on Symbols, Units, and Nomenclature (SUN) in 1931 (discussed in the chapters by Fauque and Fox, and Navarro). In particular, the mission of the commission was perfectly in line with the description of the pursuit of cognitive homogeneity in physics as described by Crawford et al. Before 1947, the other existing commission was the one on publications which, though rather irrelevant, confirms the centrality of standardization processes in IUPAP's actions, in this case in the search for standards in the main scholarly communication venue in physics, namely, scientific journals. Standardization also remained a major focus of attention for IUPAP after World War II, with the SUN Commission becoming one of the most relevant within the Union (from 1966 in connection with other ventures, such as the establishment of the Committee on Data of the ICSU, CODATA).[31] Doran's chapter further exemplifies the importance of this aspect by looking at how light instruments enabled precision measurement and how IUPAP became a venue, albeit not the only one, where metrological negotiations took place.

That said, standardization was far from being the only area of intervention of IUPAP after it restarted its activities in 1947. As shown by Lalli, while the refoundation centered on re-establishing clear and well-defined relations between physics and politics in IUPAP actions, the result was the blossoming of topical commissions devoted to specific sub-fields of research (Figure I.1). In part, the creation of commissions might be interpreted as a standardization process of an international community defining the sub-disciplinary architecture of physics. However, what was being produced was a social disciplinary structure of physics with definitions of hierarchies, both social and cognitive. In addition, commissions had often the ambition to organize the field of research in a project-oriented fashion. Overall, the chapters in the volume demonstrate how standardization gradually lost its primary position in the framework of IUPAP activities since the early Cold War period. Lalli argues that the creation of topical commissions was the activity that most characterizes a radical shift in IUPAP's role from an organization primarily aimed at providing standards into an organization that aspired to lay the conditions for scientific exchanges and actual cooperation.

Boundary work was being pursued in the process of forming commissions, in the negotiations within a commission, and in the relations between commissions, often leading to recognizing the necessity of cooperation among commissions for addressing specific topics.[32] Intra- and inter-commission negotiations could actually be problematic, as shown by Fauque and Van Tiggelen in the case of the Joint Commission on Radioactivity, which IUPAP shared with the International Union of Pure and Applied Chemistry (IUPAC). Indeed, the boundary between disciplines (physics

[31] This is a preliminary result of the ongoing international ERC AdG research project "Negotiating World Research Data: A Science Diplomacy Study" led by Simone Turchetti, available at https://neworldata.org/.

[32] For the notion of boundary work, see Thomas F. Gieryn, *Cultural Boundaries of Science: Credibility on the Line* (Chicago: University of Chicago Press, 1999).

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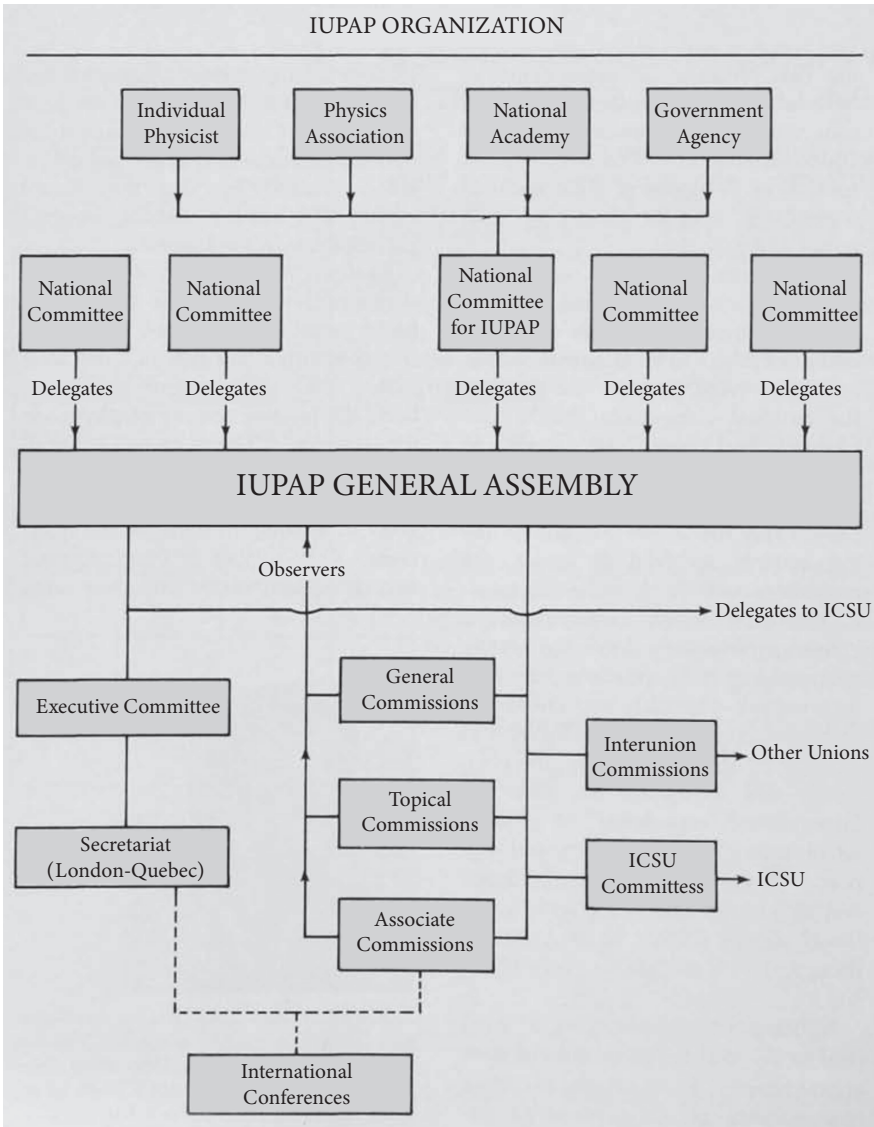


Figure I.1 IUPAP organizational chart in 1969

Source: Reproduced from Larkin Kerwin, "The International Union of Pure and Applied Physics," *Physics Today* 22, no. 5 (1969): 53–5, on 54, with the permission of the American Institute of Physics.

and chemistry), between epistemic traditions (in the evolving field of radioactivity), between institutional interests (the claims to preserve the pre-eminence of Curie's laboratory), as well as the affinity or animosity between individual scientists (Frédéric Joliot-Curie), shaped the formation, evolution, and in this case, the demise of commissions and inter-union commissions.

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IUPAP was also an instrument to globally navigate the relations between pure and applied physics. Martin shows how the emergence of a distinction between putative pure and applied realms depended on an ambition, especially in the US context, to motivate investments in basic research. This distinction did have an impact on IUPAP activities defining an imbalance in favor of non-applied research. Cold War imperatives, as shown in Hof's chapter, heightened this imbalance further in the name of "purity" in relation to high-energy particle physics, whereas support to physics activities in developing countries, in line with UNESCO's agenda, tipped the balance slightly in favor of applied (industrial) physics.

Support to developing countries, when combined to another key item in UNESCO's agenda, i.e., education, also shows the widening scientific interests within IUPAP in the post-war period as a matter of diplomatic engagement with the UN agency, which can be seen in the proceedings of the Union's Commission on Physics Education. As Simon's chapter shows, however, there was a significant mismatch between preconceived views on what IUPAP wished to prioritize and the actual status of physics education in developing countries. Moreover, IUPAP's efforts to promote industrial physics at the end of the century reflected the Union's ambition to become a global actor.

But since IUPAP was part of an organizational structure for international science, with all unions integrated in an umbrella organization centered in ICSU (see Figure I.2), and this umbrella organization faced similar issues related to changing political context, it is legitimate to wonder to what extent IUPAP's attainments, in the scientific and policy realms, were unique. Various chapters in the volume reveal this to be the case.

The Specificity of IUPAP History

A premise is in order. The relations between ICSU and the unions changed considerably over the years. Until the creation of ICSU in 1931, unions were essentially IRC sections. After its establishment, unions had a greater degree of autonomy. The 1946 agreement between ICSU and UNESCO changed these relations again, for while decision-making within unions remained largely autonomous, UNESCO funding was made available for international conferences and joint commissions, hence shaping their initiatives and instigating competition between unions.

However, while sharing an interest in taking part in this race, IUPAP shaped an almost unique profile as a science diplomacy organization by embracing critical decisions regarding membership and the free circulation of scientists that other unions (or even ICSU at large) would not endorse so wholeheartedly. Why physicists were more ready than other kinds of scientists to take bold stances on matters of global relevance regarding international science is difficult to say. It is worth reminding, however, that since the end of World War II physicists have played politically relevant roles in various other arenas. Many had been involved in the campaign against nuclear proliferation and paid the price for this involvement through McCarthy's

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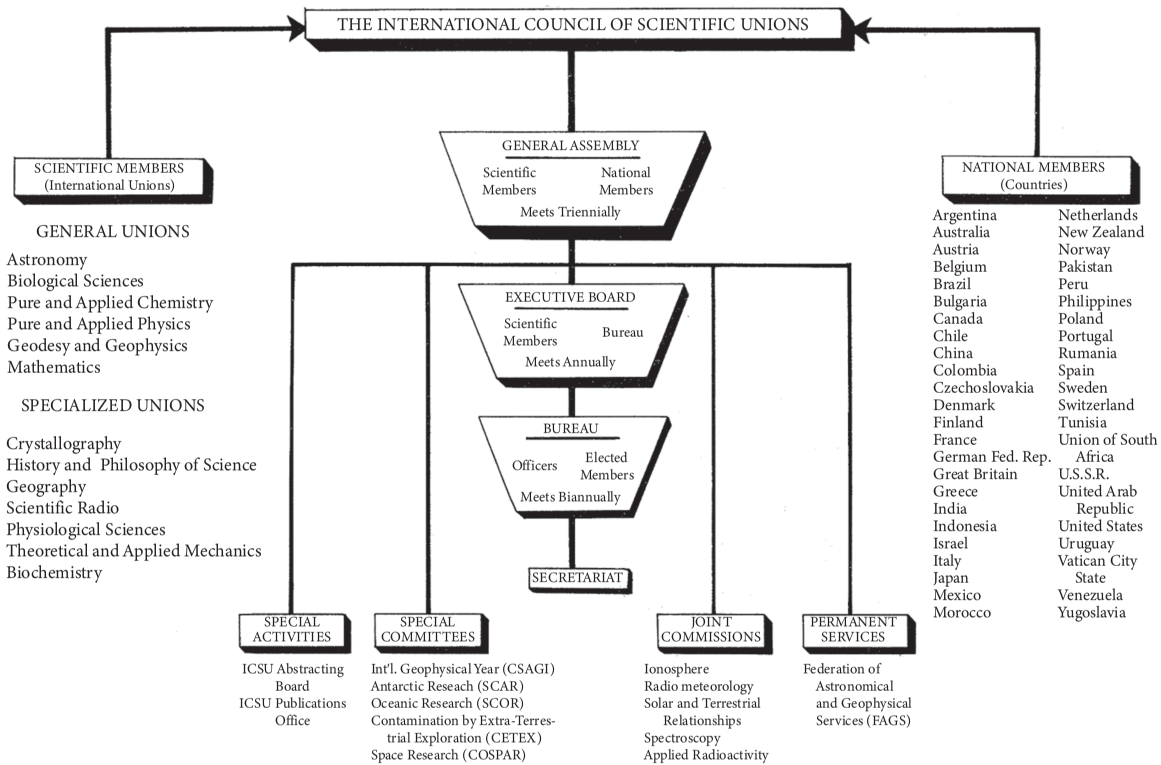


Figure I.2 Organizational chart of ICSU in 1958

Source: Reproduced from Atwood, Wallace W. "International Council of Scientific Unions," *Science* 128, no. 3338 (1958): 1558–61, on 1559, with the permission of the American Association for the Advancement of Science.

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witch-hunt.[33] Some institutionalized this campaigning through transnational political organizations like Pugwash.[34] Especially during the war in Vietnam, the physics community split over the contribution that physicists should have given to the conflict, some advocating advising US government while others considering these advisory roles as contributing to a genocide in Vietnam.[35]

It should not be a surprise therefore that IUPAP officials were virtually at the forefront of a number of campaigns eventually endorsed by ICSU and the other unions. IUPAP was, for instance, the first union to offer national membership to an East German scientific organization. It is true that, as Olšáková shows, in so doing IUPAP was simply the first union to fully implement the principle of political non-discrimination that ICSU had already approved at its 1958 general assembly. Even so, its leaders displayed a considerable level of boldness, given that the matter of acceptance of an East German organization was highly contentious at an international level due to the non-recognition of the East German state in the "free world." As discussed in Cozzoli's chapter, the then President Edoardo Amaldi in particular must have been aware that IUPAP's move would produce a domino effect, with East German committees separately requesting acceptance in ICSU and other unions, and making it difficult for their officials to refuse it in light of the precedent set by IUPAP.

Likewise, the IUPAP Executive Committee agreed to accept the Physical Society of Taiwan without waiting the formal indication by ICSU, in spite of proposals to wait for ICSU's decisions on these matters. As shown by Hu, Liu and Yin, the controversy regarding the PRC and ROC membership extended to other unions, but in the combined acceptance of Taiwan and GDR as national members in 1959, IUPAP pioneered an argument based on a symmetry in relation to the opposite pressures of Cold War blocs.

The highly divisive issue of the free circulation of scientists displays once again a pioneering role for IUPAP. As shown in Turchetti's chapter, IUPAP took the lead in forwarding an official protest to NATO for the ban to East German scientists travelling to Western countries. Bhabha's letter to the NATO Assistant Secretary General for Scientific Affairs informed further correspondence by the ICSU Secretary and Executive Board who extended the Indian physicist's pledge, paving the way to the establishment, in 1963, of an ICSU Standing Committee on the Free Circulation of Scientists.

IUPAP's development as a scientific organization also differed from that of other unions. As discussed in the chapters by Fauque and Fox, and Navarro, IUPAP often operated according to a discipline-specific agenda. It was mostly inactive in the period between the two World Wars, and the only two scientific commissions established

[33] Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill, NC: University of North Carolina Press, 1999); David Kaiser, "The Atomic Secret in Red Hands? American Suspicions of Theoretical Physicists During the Early Cold War," *Representations* 90, no. 1 (2005): 28–60.

[34] Alison Kraft and Carola Sachse, *Science, (Anti-) Communism and Diplomacy: The Pugwash Conferences on Science and World Affairs in the Early Cold War* (Leiden; Boston: Brill, 2020).

[35] Gerardo Ienna and Simone Turchetti, "JASON in Europe: Contestation and the physicists' dilemma about the Vietnam War," *Physics in Perspective* 25 (2023): 85–105.

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were general in scope, primarily dealing with standardization. This was in stark contrast to the IAU, which by the early 1920s had already created thirty-two commissions dedicated to specific research topics. It remained in the middle ground between unions that put forward scientific agendas despite the limitation of the international participation due to the exclusion of Central Powers' scientists, like the IAU, and those unions that were completely dismantled because of the political issue of exclusion of Germans, like the International Mathematical Union (IMU). In a way, the interwar period saw IUPAP failing in many respects, especially in the involvement of Germans, but it was precisely the decision to continue maintaining the existence of the organization despite these failures that allowed IUPAP to resurge from its ashes after World War II and gain a central place in the international re-organization of physics.

Hence IUPAP was not simply and not only a manifestation of broader processes of international scientific coordination applied to the physics realm. It was a venue for autonomous decision-making processes where physicists were the primary actors in relations to governments, other institutions, and networks of similar organizations under the ICSU umbrella.

Individuals in IUPAP

The issue of autonomous decision-making calls into question another key issue that this volume posits; namely, to what extent individuals informed institutional decisions at IUPAP. Drawing on works that have revealed the multiple roles that some scientists could play in the international arena (as policymakers and at times even intelligence agents), the chapters in the volume display the significance of individual interventions in era-defining issues for IUPAP's history.[36]

The role of IUPAP Presidents in designing and implementing specific agendas is particularly evident in these analyses. For instance, Navarro shows how the energetic US physicist Robert Millikan saw IUPAP as an important platform for extending a US hegemony over the physical sciences during the 1930s, and his promotion of an enlargement of IUPAP to former enemy countries further confirms this ambition. Millikan's attempts were largely unsuccessful, but they show how individual agendas modelled actions and membership in the Union.

Edoardo Amaldi had an equally central role in shaping Italian physics in the decades after World War II and in institution-building at the European level. Amaldi's personal political stances and his central position in Italian policy-making in physics made him the ideal figure to lead IUPAP into a fundamental transition of its history, when the Union transformed into an institution based on the balance between Cold War blocs with the Soviet membership of 1957. As discussed by Cozzoli,

[36] Ronald E. Doel, "Scientists as Policymakers, Advisors, and Intelligence Agents: Linking Contemporary Diplomatic History with the History of Contemporary Science," in *The Historiography of Contemporary Science and Technology*, ed. Thomas Söderqvist (Amsterdam: Harwood Academic, 1997), 215–44. A particular relevant case was the Pugwash movement, see Kraft and Sachse, *Science, (Anti-)Communism and Diplomacy*; and Alison Kraft, *From Dissent to Diplomacy: The Pugwash Project During the 1960s Cold War* (Cham: Springer International Publishing, 2022).

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Amaldi's views in the negotiation opened the entrance of both Taiwan and the GDR as a manifestation of symmetry between Western and Soviet blocs. In addition, he proposed rules and norms that govern the functioning of IUPAP to this day.

In these negotiations, Amaldi was also responsible for promoting the election of Indian nuclear physicist Homi Bhabha as the next President, opening the presidency to representatives of developing and non-aligned countries. Bhabha then played a central role in his political protest of the NATO ban against East German physicists, which had momentous consequences for IUPAP as an international organization (as shown by Turchetti). The Soviet physicist Dmitry Ivanovich Blokhintsev, who was the IUPAP President in the period 1966–69, helped to implement a change of the notion of scientific internationalism that would enable Eastern bloc countries to join the Union more readily, as shown by Silva Neto and Kojevnikov. While only the activities of a few Presidents are discussed in detail in the volume, they reveal the continuous interplay between broader historical forces and the responses of individuals in positions of responsibility in the organization in particularly crucial historical transitions.

IUPAP meant a lot for individual physicists outside the organization's leadership too. IUPAP is thus revealed in Da Silva's chapter to have played a key role in the Russian-Italian physicist Gleb Wataghin's attempt to establish cultural and scientific contacts with his former homeland Russia, exactly in the period when the Soviet Union joined international cooperation. Alignment of individual and institutional agendas is also central in the organization of the International Conference of Theoretical Physics in Japan that Ito discusses in his chapter. "The almost invisible 'Japanese guy[s],'" Ito tells us, spent a considerable amount of their time in organizing the meeting to restore contacts with the international physical community after World War II, aware of the political implications of this opening. These efforts had scientific consequences as well, for the Japanese physicists themselves eventually got international scientific recognition, also through IUPAP.

Conclusion: Why a History of IUPAP?

IUPAP was not a simple manifestation of broader processes or implementation of decisions made elsewhere. IUPAP was a venue and an engine for negotiations at different levels in which individual agendas, institutional processes, and governmental imperatives interacted within the broader global political and scientific contexts to define the policies of the organization. Like other unions, and in relation to ICSU and the other unions, IUPAP then represents a privileged window to investigate two challenging and interconnected problems in the history of science.

The first problem concerns the dichotomy of universalism and contextualism in the natural sciences: while, on the one hand, natural sciences aspire to universality by virtue of their rigorous formal and experimental methods, on the other hand, like any human activity, they depend on situated historical and political contexts. The second involves the historical transformations of the ideal and practices of scientific internationalism and their impacts on science diplomacy during the twentieth century, namely, how the contextually dependent contrast between internationalist views

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and national constraints shaped scientific activities and, consequently, the function of scientific cooperation in international political relations.

Beyond the relevance of physics, the reasons for making IUPAP such a privileged point of observation of the previously mentioned issues is the fact that IUPAP is, and was, legally an NGO. This implies that its decision-making processes had necessarily to be discussed by individuals whose status was of non-state actors, whatever their covert or open connection with governmental agendas of their nations might have been. In addition, IUPAP is a generalist organization that is not dedicated to specific projects but to a discipline tout court, in this way allowing to study how the discipline has been built at the global level and how politics and science interacted in the socio-institutional process of discipline making.

IUPAP officers had to take their multiple roles in national and international science (and science policymaking) into account in all discussions related to scientific matters as well as to their relation to the broader political, economic, social, and cultural contexts. Clearly, the global promotion and advancement of physics was their main preoccupation, but it could not be the only one. They had to interpret physics tout court, and its evolving branches, as part of a complex global dimension, and a crucial one. By looking at IUPAP as a hybrid science diplomacy agent, and by discussing the interactions between scientists, other organizations, and governments in shaping its activities, the chapters in this volume have reconstructed key transitions in these negotiations, showing the non-trivial connections between global political and scientific orders.

It was not our intent to write a complete history of IUPAP since its inception to this day. Many relevant actors, events, and processes could not be discussed in detail. But we hope that the chapters dealing with case studies and the analytic views offered in this introduction and various chapters provide a framework both for interpreting the broad scopes of these scientific international organizations in their historical unfolding and for capturing the specific role IUPAP played in some key moments.

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