MEXICAN SCIENCE DURING THE COLD WAR: AN AGENDA FOR PHYSICS AND THE LIFE SCIENCES

GISELA MATEOS
EDNA SUÁREZ DÍAZ

ABSTRACT. This paper aims to offer a programmatic agenda for a social history of science and technology of Mexico during the Cold War period (from 1950 to the mid-1980s). We take into account recent trends in the field of science studies, such as the inclusion of postcolonial studies and a robust attention to the circulation of knowledge, understood as the traveling of scientific practices, people, tools and materials. After a brief survey on the international literature on Cold War science, including Latin America and Mexico, we introduce two requirements: a symmetrical treatment of global and local (Mexican) historical trajectories, and the necessity to write interconnected stories to account for the co-construction of the US scientific and technological hegemony after World War II. Finally, we provide a set of specific questions to be answered by historians of Mexican physics and life sciences during this period.

KEY WORDS. Cold War science, social history of science, postcolonial science, knowledge circulation, scientific practice, interconnected historical trajectories, American hegemony, Mexican physics, Mexican life sciences.

INTRODUCTION

An insightful paper written by Alexis de Greiff and Mauricio Nieto (2006 English version, 2009 Spanish version) focuses on the state of the historiography of science in Latin America during the Cold War period. According to the authors, the twin discourses of development and dependence have dominated the landscape of economic and political studies in Latin American countries. However, detailed studies on science and technology have been absent in both kinds of analysis, despite the fact that scientific and technological development are a core ingredient in the explanations to the alleged asymmetries between North and South, developed and underdeveloped countries, or center and periphery. De Greiff and Nieto forcefully argue for a historiography that incorporates postcolonial studies in the history of science and technology, and a thorough revision of the

Departamento de Biología, Facultad de Ciencias, Universidad Nacional Autónoma de México. / edna.suarezd@googlemail.com

participation of Latin American countries in the co-construction of American hegemony in scientific and technological matters during the second half of the twentieth century [1].

In general, we agree with this diagnosis, and the purpose of this paper is to provide specific ideas to enrich historical accounts of Latin American science in such period and, in particular, the Mexican case. Moreover, echoing De Greiff and Nietos call for a more symmetrical treatment of the history of postwar science in the region, we discuss different research strategies for historians of Cold War science in Latin America [2]. We expect that our proposals, and the brief case studies on nuclear physics and the research on human populations in Mexico we provide, will contribute to broader debates on the global history of science. Among these, we are particularly interested in the specificities of the circulation of knowledge that took place during this period between Mexico and the United States—via *standardization* and *internationalization*—and how this circulation contributed to the co-construction of American postwar hegemony on scientific matters. If a more symmetrical account is desirable, a view from the South should provide a unique mirror for the metropolitan face of science.

We start with a brief presentation of the recent historiography of science during the Cold War period. As recent studies on this period have shown, the Cold War does not start with the postwar period. According to the historian Jessica Wang (1999), the former period comprises the years between the end of the war in 1945 through 1950, while the Cold War extends from 1950 (when the ideological-political confrontation is built), up to 1985, with the beginning of the Perestroika. The latter is not a homogeneous time-line, on the contrary, it includes different phases that detailed studies should reveal. It must be noticed, from the start, that although much historical research has been done at the United States (and less on Soviet science), part of the novelty in Cold War studies is the inclusion, in recent years, of postcolonial studies and the concomitant publication of detailed case-studies of instruments, devices, people and fields in countries not considered "central" to the East-West confrontation such as India, China, South Africa and Iran (see the special volume of *Osiris*, 2006; for a sample, Leslie and Kargon 2006).

Following the presentation of the questions opened up by these studies, the second section provides a diagnosis of the field in Latin America and Mexico, while the third section offers a few methodological proposals specific for the Mexican case. The fourth section is an overview of the field of nuclear physics and the biomedical attempts to characterize human populations in Mexico in the 1950s and 1960s. This section offers a reflection of what seems to be local, sometimes regional, features of science in this period and provides an active agenda of specific questions to be

answered by empirical research and further analysis. Finally, we make some concluding remarks on the difficulties and the advantages of writing recent history of science in Latin America and Mexico.

THE RECENT HISTORIOGRAPHY ON COLD WAR SCIENCE

The Cold War period has become a hot subject for historians of science in the last two decades (McMahon 1994, Whitfield 1996). While the history of technology had had good reasons to write popular histories of symbolic artifacts and people, such as atomic weapons, computers, airplanes, and their architects (i. e., Hughes 1998), the history of science had until recently remained largely outside the scope. Once classified sources were released, historians of physics began digging on the particularities of different countries and contexts (Wang 1999, Kaiser 2002, Creager 2002, Bruno 2003, Krige 2006, 2008, Hamblin 2007, Gordin 2010, Strasser 2009 to name just a few). Nevertheless, the first attempts to give historical accounts for the period took place around the umbrella term of "Big Science", a term originally established in the scientific context (Weinberg 1961). This historiography led to national histories of nuclear programs and high-energy physics, and a fruitful analysis of scientific practices and instruments, enabling a first access to the intimate relationship between science, industry and the military, yet leaving out the larger political environment surrounding this arrangement (Galison 1987, 1997, Galison and Hevly 1992, Seidel 1986).

A parallel development took place among historians of science more preoccupied with the political environment of twentieth century physics. Paul Forman's pioneering paper (1987) on the relation between the development of quantum electronics and the military in the United States opened the whole field to radically new questions. These include the impact of the exponential growth of funding for particular scientific agendas (in the decades of 1950 and 1960) and the expansion of the research system of national laboratories to both industry and universities. Forman explicitly used the political-ideological category of the "Cold War" to set up the context where these developments took place [3]. Moreover, based on a thorough statistical analysis, and drawing on his political thesis and previous research on the history of quantum physics, he argued that the influence of the military had shaped scientific research towards the practical necessities of warfare and away from classical areas such as astronomy.

Although not strictly focused on the Cold War, John Heilbron and Robert Seidel's study on the Lawrence Rad Lab in Berkeley (1989) followed the transition from interwar physics to Big Science during the war. Including a thorough reconstruction of the practices, instruments and negotia-

tions between scientists and the army that made up this prestigious laboratory, Heilbron and Seidel kept up with a detailed analysis of science and technology, without forgetting the larger political and military context.

Building upon these and other developments within historical research, the last two decades have witness new trends in the historiography of Cold War science. A) Detailed case studies on the impact of the military on particular fields of research including, among others, electronics (Forman 1987), physics (Herran 2006 Kevles 1990, 1995, Seidel 2001), molecular biology (Kay 2002, De Chadarevian 2003, Strasser 2009), and biochemistry (Geiger 1992, Creager y Santesmases 2006, Creager 2006, 2009). Research in this area has provided ample evidence on the circulation of people, instruments, practices, data and substances that are a trademark of the period and the material substrate of international collaboration. B) Studies on the changing relation between scientists, universities, industry and the military during the Cold War, stressing not just the growth of the industrial-military apparatus, but also resistance, espionage and political prosecution and anti-establishment movements, in particular the rise of counter-culture (Wang 1999, Moore 2008, Wright 1994, Vettel 2006, Gordin 2010, Kaiser 2011, Krige, 2010 Kusnick and Gilbert 2010). C) Postcolonial studies, illustrated by research on the developments of the atomic program in India, Pakistan (Abraham 1998), South Africa (Hecht 2006) and China (Wang 2010). A notable subfield in this kind of research comprises studies of *nuclearity* (as defined below) in different countries, accounting for the building of national policies around a specific technology: the military and pacific uses of atomic energy. D) Finally, studies on international scientific collaboration and the co-construction of American scientific and technological hegemony (Krige 2006, 2008, 2010, Miller 2006).

Despite the diversity of subjects and themes, there are some features common to this group of historical studies: a trend towards a *transnational* history of science and dissolution of national, disciplinary and institutional histories. It is not coincidence, thus, that circulation, standardization, international collaboration and the evolving American global hegemony constitute the main areas of interest and the lens through which the history of the period is analyzed.

COLD WAR HISTORY OF SCIENCE FOR LATIN AMERICA AND MEXICO

Compared to the above developments, the history of Cold War science in Latin America and Mexico has been astonishingly scarce and rather unresponsive to the debates taking place in the international community of the specialized historians. Earlier attempts to write histories of science of Latin America faced a paradox with profound consequences: the theories and

models accounting for the "differences" between regions were incorporated in the writing of history, thus reinforcing categories and explanations in need of historical contextualization. Theories of development prescribed that economic and political progress would arise from investment on the transfer of scientific knowledge and technological systems and devices, from the so-called "developed" countries to the "underdeveloped" ones. Given the hemispheric geopolitics and the assumption that development is embodied in northern industrialized countries, this transfer would take place in one-way direction from Europe and the United States to the Southern countries. As some authors have pointed out (Sosa 2000), theories of development had their obvious correlate in the long-lasting vision illustrated by George Basalla's three-stage diffusion model (Basalla 1967). This view also permeates the industry-size historical research on the introduction of a given scientific field or theory in one of the peripheral countries.

A response to the discourse on development was given by dependence theorists in a debate that extended from the 1950s through the early 1970s. Echoing the Cold War struggle between "state-run socialist" and "free-market" economies, theories on dependence were born within an institutional context created by the postwar order: the ECLAC (Economic Commission for Latin America and the Caribbean), a branch of the United Nations created in 1948 to promote regional development. Latin American critical scholars like Celso Furtado, Theotonio Dos Santos and Ruy Mauro Marini linked the economic asymmetries between the "center" and the "periphery" to the unequal structure of the world economy and the conservative role of foreign and local elites. The correlate to this social-economic theory is a type of history of science focused on national histories of disciplines and institutions, acknowledging relations (collaborations and transnational support), asymmetries and differences, and making them explicit for a valuable thorough comprehension of local contexts. The tension between the local and the global was assumed to be a result of the asymmetrical structure of the world. This second-generation history of science is best exemplified in the detailed analysis of institutions and fields of research written by Marcos Cueto (2006) and Hebe Vessuri (2006).

From a historiographical perspective, however, there is a crucial difference between the two approaches. In sharp contrast to theories of development, dependence theories explained the "underdeveloped" features of peripheral countries *as a result* of built-in structural differences with the center, not as *a previous stage* in the process towards development. Such reading of history inverts the arrow of time of traditional accounts in the history of science, so to speak. It is not just the "North" which explains the "South," it is the metropolis that cannot be understood without the periphery. Both are the outcome of the same historical process; the metropo-

lis cannot exist without the historical asymmetries brought about by the construction of the periphery. Dependence theories reflect a growing self-consciousness of Latin American—and Asian and African—countries, resulting from postcolonial realities and, equally interesting from our perspective, from the Cold War context (Sosa 2000). Indeed, the peripheral countries had a very different experience of what, from an American-Western Europe or Soviet perspective, appeared as an ideological crash between two widely divergent political systems. For Latin America the big differences between the region and the developed North were economic and practical, whereas the Soviet and Chinese revolutions were seen as fast-track roads to bridge the technological and industrial gap (Sosa 2000). Nationalisms—as depicted by dependence theorists as a defense of internal markets—played an important role in this context, even if they were often interpreted as "socialist" programs in the midst of the anti-communist hysteria. The Mexican case is exemplary in this realm, given the socialist-tainted nationalism that pervaded many of the state initiatives in the interwar and early postwar years.

The Cold War, thus, poses serious challenges to historians of science since, as we noted, Latin American countries lived a very different geo-socio-political experience of this period in comparison to their northern counterparts. As De Grief and Nieto have noticed, this was indeed a very "hot war" for many countries on the region. Aligned with local elites, the United States intervened in several coups d'Etat (Guatemala in 1954, Brazil 1964, Argentina 1966-1770, 1976, Bolivia 1971, Chile 1973, Uruguay 1973), and faced social unrest in many countries from the 1960s up to the 1980s (for instance, through the infamous "School of the Americas" situated in Panamá from 1946 to 1984, where more than 66 000 Latin American military were trained to fight communism in their countries). In this context, Mexico's political mood was relatively stable and characterized by a schizophrenic stance towards the United States and the rest of the Latin American countries. On the one hand, Mexico acted as a resistance wall against Unite States interventionist policies; for instance, Mexico was a refugee place for Spanish and Latin American political leftist exiles and was recognized as having relatively autonomous foreign and international affairs policies. On the other hand, the country was seen, from the South, as more politically and economically allied to the United States than their Southern partners—thanks to the post-revolutionary regimes—and, as new sources reveal, Mexico was a close watched scenario of international espionage (Morley 2010).

A renew historiography of postwar science in Latin America and Mexico should be able to integrate the above theoretical and empirical contributions. *The analytical study of science and technology in postwar Latin America, however, has lagged behind.* Though the history of science during the nine-

teenth century and the beginning of the twentieth century is abundant and has excellent examples, the period after the Second Word War has not attracted the attention of students of science, a point at which we will comeback in the following sections and the concluding remarks.

This does not mean that there have been no attempts to write the history of particular fields in the postwar and Cold War physical and life sciences. The social history of science in Argentina, Brazil, Venezuela and Colombia has produced first-grade studies that show the importance of studying science and technology at the "periphery" to understand scientific practices and the construction of hegemonic views through international collaboration in the postwar world. In particular, the role of the Rockefeller Foundation in Latin America has given impulse to important historical research. Marcos Cueto's book on malaria eradication in Mexico (2009), for instance, shows the profound relations between the foundation and Mexican physicians. Another example of this collaboration is the study of the Green Revolution and the role played by the such foundation (Barahona 2009, Cueto 2007, Harwood 2009), as well as the recent socio-historical study on the *barbasco* industry in Mexico by Gabriela Soto Laveaga (2010).

Focusing on Mexico, a few studies in the history of science during the Cold War have recently been published. For instance, Azuela and Talancón (1999) studied the Mexican nuclear project from the 1940s and the 1950s up to the acquisition of a nuclear reactor set in use at the Laguna Verde nuclear plant in 1989. Though they make a brief reference to the impact of WWII on Mexican nuclear physics, their book extends over a long period of national history, and it is centered on local or national politics (such as the intervention of labor unions in nuclear policy), while the circulation of international practices and their establishment in Mexican settings is missing.

For his part, Domínguez (2000) approaches the early development of nuclear physics in Mexico, relating it to the creation of the Comisión Nacional de Energía Nuclear (CNEN, National Commission of Nuclear Energy) in the 1950s through the early 1960s. Though Dominguez attempts to link the history of nuclear physics to political and international events, and offers a more detailed account (having been able to access several sources at the National University of Mexico), he misses the scientific practices and technological artifacts involved, and the scientific collaborations behind them. For instance, he takes for granted the acquisition of the Van der Graaf accelerator, a crucial instrument in the establishment of the experimental practices of physicists in Mexico, as we will see below. In doing so, he ends up writing a traditional national-disciplinary account. Ramos (2006) has also written on the subject with the same end results.

Bartolucci (2000) represents one of the best attempts to write a social history of Mexican science during this period. He traces the origins of the

astronomer's community in Mexico during the 1940s, illustrating how the influence of the United States and American scientists shaped astrophysics in Mexico. However, the broader international political context is lacking, failing to elaborate on the scenarios that were decisive in the promotion of international scientific collaboration.

The study of the life sciences in Mexico during the Cold War period is even more incomplete than the case of the physical sciences. Barahona (with Pinar and Ayala 2003, Barahona 2009) has written extensively on the institutionalization of genetics in Mexico, though her approach emphasize a strictly disciplinary perspective. She makes explicit reference to the creation of the Programa de Genética y Radiobiología in 1960 as part of the CNEN, but she does not link these events to the social and international context where the life sciences played a central role in the promotion of the pacific uses of atomic energy. A similar approach characterizes most of the papers on local histories of science in Latin America edited by Saldaña (1996 Spanish version, 2006 English version). In most of these analysis the local-global relation is again approached from the point of view of the center-periphery (a feature of dependence theories), renouncing to contribute to a global or international history of science.

This literature has one thing in common. With the exception of Marcos Cueto (2006, 2007), the authors have not looked at relevant international archives, thus missing an important part within the scientific and technological interchanges characterizing the events they studied. This might be related to these authors' interests in their national disciplinary histories of science, and not just to the secrecy of government archival sources. After all, there has been access to archival resources of international organizations and philanthropic foundations for a long time.

STRATEGIES FOR A SYMMETRICAL AND INTERCONNECTED HISTORY OF COLD WAR SCIENCE

Although the above landscape is not very optimistic, there is a growing and promising interest to start new kinds of research in this area. De Greiff and Nietos paper is important as it points a to-do-list for historians of science in the region, the most important being a discussion of the very terms in which the historiography of science in Latin America has proceeded. To this general purpose we should add the view that an inclusive contemporary history of Latin American and Mexican science and technology must contribute to an understanding of how the global-local divide was enacted and acted upon during the Cold War period, including a broader narrative on the co-construction of American hegemony in scientific and technological matters after WWII that symmetrically incorporates "the South". And second, the history of science in Mexico must take into

account the overlapping and intersection of local and global trajectories. *In brief, a new history of science for the region should not be restricted to the Mexican and Latin American contexts, but incorporate the rest of the world.* As Sanjay Subrahmanyam has suggested, for the Eurasian case, we need "connected histories as oppose to comparative histories" (1997, p. 745).

What exactly does it mean to write symmetrical and interconnected stories, *versus* the more usual comparative ones? If we draw from the experience of postcolonial studies, it means, foremost, the incorporation of the history of the circulation of scientific practices that is the trademark of recent historical research. This requires two different but complementary research-writing strategies. On the one hand, it requires the writing of *thick* histories of case studies in various fields of research, including detailed accounts of how scientific practices and devices traveled between North and South during the years after the war. Moreover, we need studies on how those objects and practices were transformed in arrangements incorporating a wide array of social and economic actors: international organizations; national institutions; budgets; individuals and artifacts—including substances like radioisotopes, blood and organisms like fruit flies. Such narratives, by necessity, give us an interconnected, transnational trade—though not between equals or fair. The two case studies we provide below will introduce concrete examples of the questions this kind of research aims to answer.

On the other hand, we want to emphasize the need to write symmetrical accounts, namely, stories that help to understand science and technology at the *hegemonic* centers and not just at the national or local context, by bringing into the picture new problems, resources not yet analyzed, new actors, and the recognition that local autonomous trajectories shaped the different lived-experiences of the Cold War. Equally important is to figure out how these alternative trajectories helped shape the views and decisions made at the center, at least in some scientific and diplomatic arenas. Thus, we cannot limit ourselves to echo the histories of science written from the "center," reflecting political preoccupations that—at times—were the opposite of Latin American concerns during those same years. A constructive dialogue should attend to the debates and developments taking place within the international community of studies on science, providing detailed answers and perspectives that are also useful viewed from the other side. Our intention should not be to write *second-order legitimating stories (*Abir-Am 1985*)*. The scientific and technological asymmetries experienced between different national contexts should not be taken for granted and legitimated by our historical narratives, our concepts and methods.

Having said so, the question may arise of why is it important for Latin American and Mexican historians to invest on this area. An answer lies in

the fact that the Cold War is a crucial period in the impulse towards the internationalization of science and—simultaneously—the co-construction of American hegemony in science and technology, the very subject matter of economic and sociological theories attempting to understand the postwar global order. As the number of case studies in places like India, China, South Africa and Turkey has shown, historians of American science have started to recognize the one-sidedness of *the American postwar science* approach. In a recent overview of the field, Heyck and Kaiser (Focus *Isis* 2010) pointed out that one part of the story of the Cold War is the Americanization of science, and the other is the *transnationalization* of American science, as two sides of the same coin (p. 364). This means that contributions of scientists from many countries around the world (even rival countries, such as China, see Wang 2010) participate in the construction of American scientific supremacy, as well as for the internationalization of scientific practices, even if these interchanges cannot be given for granted.

Mexican scientists, of course, were part of this process. The local physicists, life scientists and physicians that took the lead on scientific matters after the war were all educated in the top American—and sometimes British— universities, and built long-term international collaborations for the institutions and fields they were responsible for. They played the main role in the implementation of new techniques and technologies in local scientific practices, and it is in this realm where we lack proper detailed case studies of social history of science. Moreover, Mexican scholars performed an instrumental job in adapting new technologies and practices in new contexts and problems, at times struggling in the midst of local resistances and/or reconfiguring those same technologies and practices to new—sometimes ironically—divergent goals. This happened even in cases of a close alignment with the techno-scientific goals of the United States institutions. It would be a mistake, however, not to acknowledge the very active role that Mexican scientists adopted in shaping the social, cultural and institutional contexts of postwar Mexico.

Indeed, an interrelated theme is "the importance of local contexts and individual agency" (Heyck and Kaiser 2010). In the Mexican case, individual agencies were placed simultaneously within the post-revolutionary regime and as part of the rhetoric and policies of post-war "modernity." A few scientists played a central role in the promotion and institutionalization of scientific research, participating in the creation of numerous institutes, schools, hospitals and local and global collaboration networks. Given the small community of scientists at the time, their relative weight in Mexico's scientific policies was huge. This is a common feature in the region's countries, which have historically concentrated their scientific efforts in a few disciplinary fields, with no significant numbers of scientists,

as noticed by Cueto for the Peruvian and Argentinean cases (1996, 2006). Influential personalities such as Alfonso Caso (anthropologist, rector of the Universidad Nacional Autónoma de México, UNAM, founder of the INAH and the INI and promoter of the study of indigenous populations), Manuel Sandoval Vallarta (MIT-educated cosmic ray physicist and promoter of the Institute of Physics at UNAM and its nuclear research program), or Nabor Carrillo (a soil mechanics engineer and also rector of the UNAM), help us to explain the nature and direction that Mexican research took in the early years after the war and navigated through the agitated times of the Cold War. As we noted above, it would be misleading to conclude that these scientists were somehow *passive* recipients of policies derived from a complex context, including the modernization of the country and the rise of Mexican post-revolutionary nationalism. In a very strong sense, these scientific actors were co-builders, together with politicians and other social actors (such as workers and peasants unions) of discourses and political practices connecting nationalism within internationalism, pro-Western market economy and pro-social welfare in an idiosyncratic manner through science and technology, all happening during a very prolific period of the twentieth century Mexican history.

The above reflection points to the fact that a reconstruction of the insertion of Mexican scientists and institutions within the scientific and technological trajectories of the Cold War, such as the American exponential growth on scientific research budgets, the relations with the military and industry, and the pressure towards international collaboration, gives us only a partial viewpoint. Indeed, this is the stance on the Cold War as seen and lived *from* the United States. It misses the impact of foreign trajectories [6] on the United States. What social historians in Mexico call the post-revolution was already in place in the interwar years. The social and economic consequences of the post-revolutionary regime, including the nationalization of oil industry by president Lázaro Cardenas in 1938, and the incorporation of Mexico as an allied country during WW II had lasting consequences for the bilateral postwar relation between Mexico and the United States. Also, the cultural offspring of Mexican society during those years (as recognized in the arts and fields such as archaeology and social anthropology), was contagious to American intellectuals and progressive movements. Indeed, the Mexican-American experience helped *shape* post-war American attitudes towards Latin American countries including standpoints towards their own Native American populations [7]. Thus, it would be unreasonable to uncritically reduce the Mexican scientific landscape to a passive recipient for the policies, interests and aims of American science without looking at the processes, mechanisms and people who, in Mexico and other countries, adopted but also resisted and transformed the United States Cold war agenda.

The Mexican case is relevant, if only because being among the most industrialized countries in the Latin American area, its geographical—though not always political—proximity to the United States, and the social revolution that redirected its social and economic trajectories. After the war, the Mexican post-revolutionary governments incorporated the discourse of modernity, as understood in current theories of development, and then substituted it—in the 1950s and 1960s—by a discursive practice dominated by dependence ideas [8]. Huge sets of unexplored questions arise from a first approximation to these events.

A first one concerns the mechanisms for building trust between Mexico and the United States, and the role of individual agencies involved in this effort on several sides [9]. As mentioned above, Mexican scientists acted as efficient operators in the translation and transformation of Mexican nationalistic, post-revolutionary and even pacifists aims, facing the priorities of private industry and military-driven US research and vice versa. This is even dramatic for physical scientists, who dealt with atomic knowledge and technologies (Azuela and Talancón 1999, Domínguez 2000). In the case of life and biomedical scientists, for instance, the US policy focused on individual and private health services and directed to fight chronic diseases was translated into the language of social equality and the expansion of basic health services (including vaccination) to marginal (indigenous and peasant) populations. How such translations, alignments and transformations of interests took place at each particular circumstance is something that only detailed case studies will reveal. Thanks to first-generation studies, we already know that scientific collaboration and education of scientists at the Unite States constituted the basis of informal transnational networks that were eventually institutionalized with the assistance of international agencies (such as the United Nations technical agencies) and American government funds (such as the Health Service and later the National Institutes of Health). Nevertheless, it must not be forgotten that given the profound mistrust and generalized political extremism characterizing this period, a complementary question is how the struggle between the Soviet Union and the United States was fought in Mexico's scientific scenario, taking into account geopolitical considerations and Mexico's role in the Cold War widespread espionage (Morley 2010). A detailed answer should reveal meaningful differences between the 1950s or the late 1960s, after J. F. Kennedy "Alliance for Progress" discourse threw attention into Latin America's social welfare and political development, impacting social policies and priorities at the national level. Also, we need to know how the ideology of "international science" and the active promotion of scientific collaboration as an instrument of foreign affairs

affected the bilateral relation between the United States and Mexico during those years.

A second group of questions deals with the participation of Mexican scientists in the co-construction of American scientific hegemony. Some areas of knowledge are particularly interesting in this context. Nuclear physics, human genetics and, in general, studies of human populations, stand as obvious examples with notable consequences for Mexican science and its institutions, as well as for making stable and normal hegemonic views and practices. Here, attention to the *circulation* of knowledge provides important clues on the standardization of scientific and other practices, sustained in techno-scientific spaces and entrenched in national institutions, including alimentary or nutrition regimes, agricultural and clinical procedures, and the medical classification and normalization of populations. Many details of such flow of knowledge are as yet unknown and constitute important subjects for future research.

The biomedical sciences, for instance, provided important data and research results that were incorporated into hegemonic scientific stands on nature and man, contributing to the current viewpoints on human populations. Such "squeezing" of data did not take place passively, by a mere adoption of techniques and technologies. The process of adapting goals and tools required social and political interventions within local and international organizations and people. Also, scientific trends were incorporated in successful and unsuccessful local projects as political and scientific elites aligned them to their particular interests, such as the "integration" of indigenous populations to mainstream health services and national standards of living (evenif they were not accomplished).

As seen from Mexico, the Cold War overlapped and intersected with the reconstruction of the Mexican state in the decades that followed the revolution started in 1910. Through the late 1930s to the 1950s, this process involved a huge social effort to build national institutions—hospitals, schools, universities—and social organizations—such as powerful workers and peasant unions organized under the long-reigning Partido de la Revolución Institucional—devoted to bring education and health to bridge the inequality of Mexican society, while protecting internal markets and favoring the new political-economic elites. This process reached its social-oriented climax during Lázaro Cardenas regime (1934-1940). After the war, during Miguel Aleman's presidency (1946-1952), the modernization of the country was interrelated to the American political standpoints, though, at the same time, Mexican economic policy protected its local industry from foreign participation. A brief example on the intersection of the physical and life sciences in Mexico during this period should illustrate the above.

Following the creation of the United Nations in 1946, the Mexican government participates in its technical agencies. As many authors have pointed out, one of the consequences of the war was the inclusion of scientific expertise on political and diplomatic agendas. According to Miller (2006), scientific cooperation was an effective instrument of foreign policy before World War II. Such cooperation had taken place via the Interdepartmental Committee on Scientific and Cultural Cooperation, created by President Franklin D. Roosevelt in 1938 to secure technical assistance programs to Latin American countries. After the war, the United Nations technical agencies took this committee as an exemplar model for international scientific and technological collaboration, using this cooperation again as an instrument of foreign policy. Indeed, one of the main features of postwar order was the inclusion of scientific and technical experts on diplomatic commissions. Such expertise was designated by national governments.

Clearly, after Hiroshima and Nagasaki, atomic energy had become a crucial political-scientific issue in international affairs. Since there were no nuclear or atomic physicists in Mexico at the time, the first representatives to international committees and events were engineers and cosmic-ray physicists. For example, Nabor Carrillo (at the moment one of the outstanding researchers on soil mechanics at the National University of Mexico) and colonel Juan Loyo González, an army engineer, were sent as representatives of the Mexican government to the Bikini Atoll nuclear test in 1946, being their first experience with such energy.

That same year, the MIT-educated physicist Manuel Sandoval-Vallarta, and Carrillo himself, participated in the failed UN Atomic Energy Commission [11]. Later on, they were among the main promoters of Mexican research on nuclear physics. The physicist Carlos Graef—a student of Sandoval Vallarta—and architect Carlos Lazo, in charge of design and construction of the science buildings at the UNAM new campus (during Miguel Aleman's period), also played a decisive role in the construction of this scientific field in Mexico. A standing feature of all these scientists was their long collaboration with scientists from MIT and Harvard. Sandoval-Vallarta had been associate professor at MIT until 1946, and assistant professor to Vannevar Bush during the interwar years, while Nabor Carrillo had gotten his MD and PhD at Harvard.

The development of nuclear physics in Mexico was promoted as part of the international discourse on the peaceful uses of atomic energy during the 1950s. In the following years, Mexico developed a national discourse on *nuclearity* [12]. The *nuclearity* of a country was a crucial qualification in those days, since it defined a given country's role and weight within

international commissions and decision making processes at many agencies, including the International Agency for Atomic Energy created in 1957 (after the failure of the UNAEC, see note 11). In 1950, the UNAM bought, through negotiations, first, between Sandoval Vallarta, Carlos Graef and Nabor Carrillo, and the American company High Voltage Engineering Corporation, and later, between the company and the University, a 2 MeV Van de Graaff generator, which cost one million pesos of that time (around 125 000 USD). As Adriana Minor (2011) has shown, this instrument acquired different meanings according to diverse interests. It became the symbol of the Mexican entrance to scientific modernization, as reflected in the government propaganda between 1950 and 1953, as it was in Carlos Lazo's vision of the new UNAM campus in the south of Mexico City. Equally important, around the Van de Graaff the circulation of people, practices and substances helped consolidate the Mexican physics community. It was through the multiple uses of this instrument and the creation of the Mexican Nuclear Energy Commission (CNEN, founded 1955 which start its operations in 1956) that the nuclearization of Mexico was constructed during the 1950s (Domínguez 2000, Minor 2011).

The CNEN was created as a result of the growing investment on the pacific uses of atomic energy launched by Eisenhower's "Atoms for Peace" international initiative, a resultant of complex political negotiations between the military and scientists in the United States in the first years after the war (see Kaiser 2010). In the midst of a fierce struggle, the United States had created its own Atomic Energy Commission in 1947 (AEC), and the United Nations finally agreed to vote for the creation of the International Atomic Energy Agency (AIEA) in 1957. José María Ortiz Tirado was named the first director of the Mexican agency (CNEN), and Sandoval-Vallarta and Carrillo were members of the commission. The advisory board included mathematician Alberto Barajas—founder of the Facultad de Ciencias at the UNAM—, Carlos Graef, then director of the Instituto de Física at UNAM, and Díaz Losada, among others. Two main branches were created at the CNEN, applications and research, including radioisotopes, genetics, agronomy and nuclear physics.

It is through the CNEN that physics and genetic human population studies were connected in Mexico. As Barahona (2009) has recounted, the Mexican delegation to the IAEA 1957 Vienne Conference, including Ortiz Tirado, Carrillo, Sandoval Vallarta and Salvador Carmona met Mexican geneticist Alfonso León de Garay, accompanying the British delegation. At the moment, León de Garay was a doctoral student of Lionel Penrose at the Galton Laboratory in London (University College), known as the cradle of human genetics after the war (see Kevles 1996). The physicists invited him to create the Genetics and Radiobiology Program at the CNEN. Back in Mexico in 1960, León de Garay (who did not get his PhD) was a

central actor in the establishment of animal genetics in Mexico. As we mentioned above, the question arises as for the origins of the radioisotopes used in his laboratory during its long-time life. Given the apparent lack of shipment data tracing supplies from the AEC in the US to Mexico (Creager 2002), a working hypothesis is that UNAM physicists provided Mexican biologists with radioisotopes coming either from the Institute of Physics at UNAM or, after 1964, from the CNEN. Such isotopes could be used on agricultural and medical applications for cancer therapy. It is unknown to us, at this moment, if the Mexican geneticists participated in the international experiments regarding the human impact of radioactive fallout (on this subject, see De Chadarevian 2002).

Human population studies, for their part, had a longer history in Mexico. Starting in the 1940s, medical doctors applied serological and biochemical techniques to characterize indigenous and "mestizo" (urban) populations. Manuel Salazar Mallén and his students contributed to the detection of hemoglobin abnormalities in rural communities starting in the mid 1940s (Barahona 2009). In the 1950s, after the creation of the Instituto Nacional Indigenista (INI, funded in 1949-1950), the archeologist-turned social anthropologist Alfonso Caso contributed to this effort, acting as an efficient mediator between the city laboratories and the marginal indigenous communities of zapotecans, mixtecos and lacandonians (Suárez and Barahona, forthcoming). Caso is also a significant "passage point" in the Mexican scientific landscape during those years. A prestigious archaeologist that had discovered the main treasury tomb (Tomb 7) at Monte Alban ruins in Oaxaca, Caso was financed by several American philanthropic foundations, such as the Viking Fund (later the Werner-Grenn), the Carnegie and the Rockefeller Foundation in the interwar and postwar years (he was awarded the Viking Fund Medal in 1953). Caso was rector of UNAM between 1944 and 1945, and in 1969 donated 500 USD for the creation of the C14 Radiochemical Laboratory at the Physics Institute, the same laboratory where radioisotopes were produced for medical and agricultural applications.

While the international mainstream studies on human variation after the war focused on individual therapeutics and counseling, the Mexican approach to human populations reflected the social policies of the Mexican state. Through the INI and the Secretaria de Salud y Asistencia (SSA) the surveys and detection of hemoglobin abnormalities aimed to improve health conditions of indigenous and marginal populations. To this end, the INI created several Centros de Coordinación (Coordinating Centers) in rural areas with major indigenous population, such as Oaxaca, Chiapas, and Michoacán. The centers, promoted by Caso, illustrate the intersection of physicians, indigenous associations and community representatives, anthropologists and primary school teachers, and they are an excellent

locus for future research on the adaptation and transformation of instruments and knowledge to different contexts and political ends.

CONCLUSIONS

The most recent historiographies of the interconnected *modern world* give voice to all parties involved. Interconnected stories have been written, to give some examples, for the American colonial period (Cañizares 2001, Safier 2010), the construction of early Modern Eurasian societies (Subrahmanyam 1997), and even for the twentieth century world order (Hecht 2006, Kaiser 2010, Krige 2006, 2008, 2010, Abraham 2006, among others). For the Mexican and Latin American case, the pervasiveness of dependence theories has resulted in national histories on several fields and disciplines for the period we are interested on. Methodological difficulties arise from the lack of national and institutional archives [13], as well as from the absence of extensive documentary research on international sources and archives. Moreover, opaqueness and secrecy have been features of the twentieth century political regimes in Mexico; it was not until 2002 that a Federal Law on Access to Information was passed by the National Congress. All of this has put an extra obstacle to the writing of recent social histories of Mexico.

To these methodological biases we have to add the acritical attitude towards science and technology in most Latin American countries. The social history of science is a nascent field in Mexico, with only a few scholars concentrated on colonial studies and nineteenth century history (certainly two of the richest historical periods), mirroring the broader conditions of research in the country. The public lack of interest in contemporary science and technology is reflected in the absence of science and tech news in the media and in the political debates [14]. Science and technology are taken for granted, and not even considered to be part of the "national culture," since they are basically seen as coming from abroad. There is also a restricted view of the Mexican social movements during the second half of the twentieth century, mostly written by the actors themselves, where such narratives fail to pay attention to the impact of counterculture and political stances concerning science and technology.

Nevertheless, as we stated in the introduction, there are good reasons for writing a history of Mexican science during the postwar and Cold War periods. It is during this time, and in close connection with events taking place in the rest of the world, that contemporary scientific practices were put in circulation and adapted to different local contexts. It is in the interconnection with such local practices that the global ones characterizing contemporary research were co-constructed. The history of contemporary science and technology should be written as a transnational

history. However, we would like to stress that Mexican trajectories during the years referred above are highly specific to this country and do not necessarily reflect what happened in the entire region.

The goals of Mexican physicists and biologists were not completely aligned to the agenda of scientists and politicians in other countries. Indeed, the Mexican approach went on the opposite direction from most international trends. Both in nuclear physics and in the life sciences the national trajectories of the post-revolution and modernization of the Mexican state had an everlasting impact. Therefore, a detailed analysis of the Mexican case helps to understand how the global pervasiveness of scientific views and technologies was constructed, and how technologies were reworked and cross-fertilized (Oldenziel and Zachmann 2009), amid of the differences in political aims and social context.

To conclude, a lot of questions are left open for further research, some of them already referred above. One of the broadest concerns is how Mexico participated in the circulation of scientific practices and instruments during the postwar and Cold War years; in particular, which instruments and substances, and whose projects, traveled across the border(s)? How Mexican scientists participated in the co-construction of American hegemony in the Latin American region? Given its geographical vicinity, and their mutual distrust, how did individual agencies in the United States and Mexico participate in this circulation of knowledge? How the Cold War conditions, including the rise of international collaboration, helped shape the Mexican physics and life sciences communities? Moreover, a crucial question for the notion of an interconnected world is the following: in which way(s) did the Mexican actors and trajectories helped shape scientific practices and knowledge at the hegemonic centers?

Science studies in the last decades have reformulated old notions and reframed historical questions on the nature of science. In part this is due to the interest on new contexts, not restricted to Europe and the United States. Latin American historians cannot escape the fact that we live in an interconnected world.

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NOTES

1 The idea of a co-construction of post-war American hegemony has been forcefully advanced by John Krige in several publications (2006, 2008, 2010). The notion of co-construction gives voice and agency to the different actors involved in the closure of a socio-technical and political event. In recent years, the sociology of science has delivered a number of important works illustrating the co-construction (or lack of it) of techno-scientific realities in different contexts, including the failed Human Diversity Project (Reardon 2004) and the regulation of biotechnologies in the European Union (Jassanoff 2005).

2 The Latin America *region* should not be taken for granted, despite the geographical and cultural definitions that traditionally have taken primacy. Detailed studies of Latin American countries and their connections should reveal the historical processes that, on scientific and technological matters *may, but not necessarily do*, link the Latin American countries into a common region.

3 In 1945, the writer George Orwell was the first to use the term "Cold War" to make reference to the ideological and political confrontation ("a peace that is no peace"), between the Western bloc—and in particular the USA—and the Soviet Union, in an article written for the English newspaper *Tribune,* entitled "You and the Atomic Bomb". The term was given wide acceptance after Walter Lippmann's book *Cold War*, published in 1947.

4 For instance, the introduction of Darwinism in Latin America genre, including Moreno de los Arcos (1989) and most of the papers included in Glick, Ruiz and Puig-Samper (1999).

5 This situation is not restricted to the history of science. In our view this might be connected to the prevailing political regime in Mexico during those decades, and the possible political consequences of writing recent history.

6 The idea of *trajectory* has a long history in studies on science and technology and should not be interpreted as assuming a deterministic or teleological meaning. Martínez and Suárez (2008) argue for different types of trajectory dependence for historical processes, all of them incorporate the crucial role of contingency on historical accounts. Such contingent elements may include values, political, social and cultural factors that have an impact in the creation and deviation of trajectories.

7 Mexican indigenism was considered the model for integrating indigenous communities in the Americas during the 1950s. In 1941, the International Congress for Indigenous Affairs was celebrated in Mexico, organized by Alfonso Caso, who was founder and first director of INI (Instituto Nacional Indigenista, created in 1949).

8 This was not the first—nor the last—time the Mexican state adopted the language of modernity. During the period between 1870 and 1910 (Porfiriato), the Mexican government relied heavily on the idea of modernization as progress and, like other Latin American countries, this discourse was tied to the rise of French positivism. In many cases, Mexican professionals (physicians, lawyers) had received their education in France (Zea 2005).

9 This includes also the participation of other Latin American countries, since a Southern "block" might have provided a more efficient front for negotiation, amid extended resistance of American trends. Indeed, the US government took pains to dominate the creation of the Organization of American States in 1948. In order to reduce the complexity of the analysis, in this paper we restrict ourselves to a more extensive analysis of the bilateral relation between Mexico and the US.

10 Currently, we are developing research to locate the origin of radioisotopes for Mexican scientists in the 1950s and 1960s, since the first list of shipments from the AEC (Creager 2002) did not include Mexico, yet included other Latin American countries such as Brazil and Argentina. On the biomedical side we are also investigating the circulation of blood samples from indigenous communities to international laboratories, mainly in the United States, via the mediation of anthropologists like Alfonso Caso. We are also starting an exploration of the circulation of instruments and laboratory devices between Mexico and the United States in this period. Other incipient projects include the circulation of theories of behavior of human populations, and the standardization of alimentary and nutrition regimes and practices in postwar Mexico.

11 The United Nations Atomic Energy Commission (UNAEC) was funded by Resolution 1 of the United Nations in January 1946, and disbanded in 1952, though it had been inactive since 1949. Mexico was a member of the Security Council in 1946. The main goals of the UNAEC were to ensure the development of pacific uses of atomic energy and the flow of scientific information regarding this technology. At the time, the United States were the sole country in possession of atomic weapons; in 1947 the US representative proposed the *Baruch Plan* wherein the US would destroy its atomic arsenal if the UN would impose controls to the development of atomic weapons. The plan was approved by the Commission in 1947 but the Soviet Union abstained in the Security Council. Since then, it was clear an agreement was very unlikely. Clearly, this is a corner event in the construction of the political confrontation of the Cold War.

12 "Nuclearity", as defined by Hecht, is "the degree to which a nation, a program, a policy, a technology, or even a material counted as "nuclear"—was a spectrum, not an on-off condition. Both nuclearity and its implications emerged in substantive ways from the dynamics between cold war and postcolonial visions of the world" [Hecht 2006, p. 26-7].

13 For example, the archives from the Institute of Physics at UNAM apparently were incinerated in the early 1980s (see Domínguez 2000), while the School of Sciences at UNAM, created in 1936-7, does not even have a historical archive.

14 The Congress Commission of Science and Technology reported, in 2009, two *pending minutes*, on changes to the national Law of Science and Technology. No other debate or resolution was reported at its website.

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