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Latin America, Spain and Portugal: Scientific Networks and Exchange with Sweden

Introduction

The interactions between Sweden and both Latin America and the Iberian peninsula have not been as intense as those between these regions and other areas of the world. Sweden interacts mainly with the other Nordic Countries, Central Europe, Southern Europe and North America (Schott, 1992: 7). The case of one Swedish university, the University of Lund, reveals that Ibero-American nodes are in the periphery. Of an estimated 2546 foreign trips by Lund's personnel in 1983, only 0.2 per cent had been to Latin America. In 1988, the number of estimated foreign trips had increased to 3788, but with the Latin American percentage declining to 0.1. Portugal was also not so very central. Of an estimated 2007 European trips in 1983, only 1.2 per cent were to Portugal. In 1988, the relevant number had increased to 3062, with the Portuguese percentage declining to 0.7. Spain fared better with 1.0 percent in 1983 increasing to 1.6 in 1988 — not much really (Cederlund, 1992: 13 and 17).

It is the fragility of these links which makes the study of the relations between Sweden nad both Latin America, Spain and Portugal interesting. Thereby we have the possibility of better understanding the interactions between central and periphery nodes in a network. Results of this study may give insights into the past — Sweden was once very peripherical (Eliasson, 1990). Today, Spain is moving back to the center. Moreover, studies of the relations between central and peripheral nodes assume a relevance because the Scandinavian countries have decided to assist Eastern and Central Europe and the Baltic Countries. At least an institution considered here, the Nordic Institute for Theoretical Physics, Nordita, which is a research center with profound Swedish participation, has developed efficient and successful mechanisms to link with the periphery.

There are two dimensions of interest when considering the flows between nodes: the flow of ideas and that of people. Ideas may flow in one direction or in both between the nodes. This flow may occur with or without

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the flow of people. When the flow of people occurs, it may also be in only one direction or in two. The combinations of type and direction of flows open six possibilities. The nodes in the periphery are primarily receivers of ideas and people. Exceptionally the flow may reverse: the visit to a central node becomes a source of authority and legitimation for the activities in the periphery.

This article presents a few examples, not a full history, of linkages between Latin America, Spain and Portugal and Sweden. First, I consider cases from the 18th, 19th and early 20th centuries, with special reference to Latin American colonials who visited Sweden and reported on its science and technology. Then, we move to a case in twentieth century physics. Nordita is at the center of a network which allows for and contributed to the flow of ideas and researchers between Sweden and Mexico, Brazil and Argentina as well as to Spain and Portugal. We conclude with a discussion of a model of the relations between central and peripheral nodes in a network.

Cases From The 18th, 19th and Early 20th centuries

The interactions between Sweden and the Iberian world go long back in history, to a shared Celtic and Gothic past. These interactions are only now beginning to be mapped (Söhrman, 1989). Travels to the Iberian Peninsula were not uncommon. Fortifications officer Eric Mynt, for instance, studied Spanish defense installations in the 1750's and joined the Spanish forces during an attack on Gibraltar — and died for it (Åberg, 1981: 280—284, cited in Söhrman, 1989: 36—37). Swedish interaction with Portugal was also common in the period and even a small Swedish colony resided in Lisbon.

The extension of the Linnean network into Latin America is also known (Sörlin, 1989: 96—123; Söhrman, 1989: 41—42). Pehr Löfling (1729—1756) was the Linnean "apostle" who described Spanish and Venezuelan flora, particularly the Orinoco area, from 1751 to 1756 (Eliasson and Sörlin, 1991; Texera Arnal, 1987). It was Löfling who brought the first microscope to Venezuela (Arends, 1986: 18). Löfling died on 22 February 1756 and his work was continued by José Celestino Mutis (1732—1808), who had a scientific correspondence with Linnaeus (On Mutis see Arboleda, 1987). Mutis sent two of his students to Sweden, Clement Ruiz Pabon and Juan José Elhuyar, in 1781 and 1782. The former studied with Linnaeus and the latter with Torben Bergman. Elhuyar, who with his brother Fausto discovered tungsten, was part of a more complex mission. Together with the Spanish Ramon de Munibe, Elhuyar surveyed weapons production in Sweden (Rydén, 1952, 1954 and 1965; Söhrman, 1989: 41—42; Lopez, 1990; Eliasson and Sörlin, 1991). Another visitor who kept records about Scandinavian technology was Francisco de Miranda (1750—1816) (Sahlin, 1992; Knudsen, 1991; Alperovich, 1989).

Thus, colonials visiting Europe were not that unusual phenomena. We know, for instance, of the case of Benjamin Franklin's stay in France. But the visit to Sweden and Denmark by the Brazilian José Bonifacio de Andrada e Silva (1763—1838), at approximately the same time as Miranda, has received little attention by historians of ideas. Not much is known yet about his visit, not even its exact dates. Most likely it occurred in 1799, at the end of Bonifacio's scientific tour of Europe. In June 1790, the Portuguese government had sent three members of its Academy of Sciences to survey the developments in mineralogy and metallurgy in Europe: the Brazilians Bonifacio and Manuel Ferreira da Camara, and the Portuguese Joaquim Pedro Fragoso.

Bonifacio graduated from Coimbra in philosophy in 1787 and in law in 1788. He was elected to the Portuguese Academy of Sciences in 1789, after submitting papers on whales, whale oil and on diamonds. As a member of the Portuguese commission, Bonifacio visited Italy, England, France, Saxonia, Sweden, Norway and Denmark. It is quite possible that José Bonifacio contributed to the spread of Lavoisier's ideas in Swe-

den, since he was acquainted with the French scientist, his experiments, theories and disciples. During the stay in Denmark and Sweden, Bonifacio and his group described new mineral varieties and fossils, collecting the 3500 samples, mostly Swedish, now in the Brazilian Imperial collection, Petropolis Museum, Rio de Janeiro. Bonifacio identified a vitreous, quite often snow-white mineral, from a sample brought from Ivigtok in the Arkasut-Fjord coast of Greenland to Denmark in 1795, naming it after the Greek word for ice: Cryolite. Results from their exploits, including Bonifacio's work about twelve minerals of Northern Europe were published in the Journal de Physique and in the Proceedings of the Royal Society of London in the period 1797—1800. After a successful carrier as Secretary of the Portuguese Academy of Sciences, Bonifacio returned to Brazil and Brazilian politics in 1819 to become the father of Brazilian independence. The hypothesis that Bonifacio was influenced by the Scandinavian political systems and thus decided to promote a Brazilian Empire is still to be verified by historians. Camara, the other Brazilian in the mission, promoted in Brazil the so-called Swedish model of smelting. He set up a smelter in Gaspar Soares, state of Minas Gerais, which produced metals by 1814 but it had been abandoned by 1830.

After the Latin American independence wars — which also involved Swedish officers like Bolivar's Tomas Fredrik Adlercreutz — Latin America received Swedes as immigrants and as travelers. Swedes also participated in knowledge travels in Latin America. From 1851 to 1853, the frigate Eugenie, with the botanist and science-writer Nils-Johan Andersson on board, undertook the first official Swedish circumnavigation, visiting Brazil, Argentine, Chile, Peru and the Galapagos Islands. Andersson surveyed Galapagos, a research which gave him the background to work for Darwinism in Sweden (Eliasson and Sörlin, 1991).

Several of the Swedish contributions to Latin America were permanent. The Brazilian National Forestry Gardens were a creation of Albert Loefgren, who arrived in the country in 1874. Swedes were also responsible for the development of institutions for wheat research. In 1919, the Brazilian government created the Alfredo Chaves Experimental Station in the city of Vereanopolis, state of Rio Grande do Sul. In 1925, the Swedish plant breeder Iwar Beckman began his wheat research at this station leading to the development of the pedigree Frontana. This and related varieties were transferred to the United States, Canada and Mexico in the 1940's and 1950's to overcome the leaf rust disease, thereby saving North American wheat agriculture (Cabral, 1992).

From the Cold War into the 21st Century: The Case of The Nordic Institute for Theoretical Physics, Nordita

Now, nearly 200 years after Bonifacio's visit, there are Nordic institutions which promote the flow of ideas and people between Sweden and several regions of the world, including Latin and Ibero America. Sweden has had a central role in the origins and development of one of them, Nordita. Today several institutions in Sweden are deeply linked to Nordita, which was created as a focal point for the convergence of theoretical physicists from the Nordic countries. Drawing on the tradition of Niels Bohr, Nordita became a center of attraction for, and interaction of, physicists from Europe and the rest of the world. The link with the Niels Bohr's Institute for Theoretical Physics is neither casual nor coincidental. Niels Bohr was one of the founders and the first chairman of Nordita.

The first post-war impetus for the creation of a Copenhagen based international institute for theoretical and nuclear physics came from the Swedish government. In 1945, it considered the possibility of supporting a center directed by Niels Bohr with 100 million Swedish Crowns (Nordita, 1982; Kiilerich, 1978; see also Nordita's Annual Reports). Unfortunately, during the Cold War secret acts and similar legislations in the

United Kingdom and the United States blocked the flow of information, central to the good functioning of an international institute. This was further complicated by the fact that Bohr was not favoured by the atomic nations because of his opposition to the military use of nuclear energy and his appeals for an open dialogue between the central powers.

The plans to build the European Organization for Nuclear Research, CERN, revived the idea of an international institute. In 1954, despite the efforts and arguments of Bohr, the 12 European governments did not place CERN in Copenhagen, but near Geneva (Krige, 1990). The Scandinavian scientific community, led by Torsten Gustafson from Sweden, Egil Hylleraas from Norway and Bohr from Denmark, responded by deciding, at a 17 January 1953 meeting in Göteborg, to organize an atomic committee. Their response reinforced the process started by the decision to locate the CERN theoretical study group in Copenhagen for the period 1952—1957. From a financial and political point of view, it also helped the first meeting of the Nordic Council on 13 February 1953. These trends favored the creation of a Nordic Center for Physics.

A series of meetings, further motivated by the expected transfer of the CERN study group to Geneva by October 1957, culminated in the creation of Nordita (Hermann et al. 1987, I: 416).[1] The Nordic Council, including Finland and Iceland, approved the decision on 21 February 1957 at its Helsinki meeting. The board and staff, meeting for the fist time on 25 June 1957, had representatives from the five countries and included widely known names such as Bohr, S. Rozental and L. Rosenfeld. Nordita would expand from atomic physics in the 1950's to other theoretical areas such as solid state physics, astrophysics and chaos in the 1990's.

Nordita was conceived as what Latour (1987) would call a "center of calculation," a place where objects and people assemble to generate and reproduce ideas. Nordita's founders created specific instruments to draw established and promising researchers to the Institute. Research fellowships are available to qualified young Nordic researchers. A number of long term positions are available for guest researchers from all over the world. Short term international visitors, participants in workshops, colloquia and meetings are a constant presence.

The Network of Nordita with Latin America, Spain and Portugal

As a result of these instruments, Nordita has built an extensive global network. In its interactions with the periphery, Nordita benefited much from the activities of the Bohr Institute, a reciprocal benefit. The nodes in the network are a function of the type of research, which has to coincide with Nordita's areas of work, the prominence and quality of the research institute at the node. The links in the network are a function of personal research contacts of the staff and visitors at Nordita. Personal knowledge, recommendations by researchers known to Nordita staff and in particular joint work with Nordita staff or with those who have visited Nordita, play an important role in establishing new links. Given the high quality of the staff, such a function has created a quality border. This border can only be crossed by individuals who come from one of the nodes or can travel through one of the links. As in any other high quality research institution, not all are accepted within the network. Although centered and focussed on the Nordic countries, the Nordita network's borders are located in a non-national, global space. The links are also a function of financial and other material resources. The flow of ideas may be possible but not always the visits by the researcher exchanging the ideas.

These barriers are very visible in the case of Latin America and the Iberian Peninsula. Both regions have contributed little to the development of twentieth century physics and have produced no nodes which could link with the Nordita network. Moreover, the post-war coupling of Latin America to the United States has tended to link their phys-

ics institutes. In Latin America and the Iberian Peninsula, long periods of totalitarian regimes prevented the emergence of nodes, the creation of links and the flow of ideas. As a result of these barriers, not of Nordita making, less than one per cent of the guests to Nordita and visits by the staff had anything to do with Latin America or the Iberian Peninsula. Nevertheless, given the circumstances, there are noteworthy results to be highlighted.

If so much was achieved with this less than one percent activity, then larger results are to be expected out of a study of the remaining ninety nine percent. And, Nordita has been much more important to Latin America and the Iberian Peninsula than the other way around. Thus, Nordita has had a role in the development of science in the periphery. Nodes in the network have survived and developed because of the flow of information along the links with Nordita. Given that Nordita is part of a European and center of a Nordic network, the exchange with Nordita has meant for the periphery the possibility of exchanges with other centers of calculations.

The Latin American Relations

Before 1979, the Iberian Peninsula, except for Christian Moller's, Nordita's director, attendance to the 1966 Space Relativity Committee Meeting in Madrid, was not present in any significant way. Nordita was primarily linked with research institutes around the River Plate: Buenos Aires in Argentina, Montevideo in Uruguay and Porto Alegre in Southern Brazil (For a personal but interesting survey of the evolution of Brazilian physics see Lopes, 1984). Exceptional was J. Nagel's participation in the 1962 Latin American School of Physics, Mexico.[2]

Theodor A. J. Maris and Gerhard Jacob, the builders of the Porto Alegre Physics Institute as a modern center, visited Nordita in this period. Maris came in February 1958 to present a colloquium on "Inelastic Scattering of 185 MeV Protons" and visited Uppsala's Gustaf Werner Institute for Nuclear Chemistry in April 1961.[3] Maris was an influential theoretical physicist in Brazil in the 1960's and 1970's (Maris, 1970).

Jacob is first mentioned in a Nordita document of September 1958, when R. A. Salmeron from CERN wrote to L. Rosenfeld to inquire whether it would be possible to receive Jacob for six months. Jacob was strongly recommended. Salmeron referred to Jacob's two presentations at the Second International Conference on Peaceful Uses of Atomic Energy, where Jacob was one of the Brazilian delegates. One his papers had been written in collaboration with Paulo Saraiva de Toledo, whom Rosenfeld knew from Manchester (Jacob and de Toledo, 1958). To further introduce Jacob, Salmeron referred to the link between Porto Alegre and Mexico.[4]

Jacob visited Nordita in November 1961, on his way to Heidelberg. He presented two papers in Uppsala, at the Institute of Theoretical Physics and at the Gustaf Werner Institute of Atomic Chemistry, a place also visited by Maris, and he gave a paper at the Stockholm Noble Institute for Physics. Jacob elaborated on the latter paper, "Double g transitions," at a Nordita colloquium.

Jacob's work became the basis of a fruitful cooperation with Tore Berggren and G. E. Brown (Berggren, Brown and Jacob, 1962; Berggren and Jacob, 1962, 1963a and 1963b). Their work concentrated on scattering and resulted in a number of international publications, particularly in Physics Letters and Nuclear Physics in 1962 and 1963. When Jacob returned to Scandinavia in May 1962, he presented these papers at the Gustaf Werner Institute of Atomic Chemistry. He visited Nordita in January 1963 and again in March 1967, already as an influential member of the Brazilian National Research Council (Jacob, 1967).

Jacob's research and scientific and administrative leadership contributed to make Porto Alegre an important research center in Latin America. Porto Alegre excelled in areas such as Mössbauer Effect and Gamma Ray Angular Correlation, particularly when ap-

plied to solid state studies. Its graduates contributed greatly to the development of other institutes in Brazil, as researchers and directors, for instance at Florianopolis in the state of Santa Catarina, at the University of Campinas, state of Sao Paulo, known as UNICAMP, and as creators of the Brazilian synchrocyclotron in Campinas. As the political climate in Argentina deteriorated, Porto Alegre became a focal point for exiled, qualified scientists. Moreover, as a result of the activities in Porto Alegre, other research institutes appeared in the state of Rio Grande do Sul. Jacob became Rector of the Porto Alegre University and, by early 1990's, the President of the Brazilian National Research Council (Schwartzmann, 1979: 453).

Brazilian and Nordic physicists continued to interact, including at the Niels Bohr Institute, but only three other Brazilians can be identified as having stayed longer periods at Nordita since Jacob. In the summer of 1986, A. O. Caldeira, a condensed matter physicist from UNICAMP's Institute of Physics, and P. Hedegard (1987) worked on particle quantum dynamics. In 1986 and 1987, Rosane Riera Freire, from the Physics Institute of the Catholic University of Rio de Janeiro, and J. A. Hertz (1987 and 1991) worked on statistical mechanics and spin glass dynamics. Even though Hertz has advanced into another research field, neural networks, he and Riera continue their contact and exchange of information. Finally, from October to December 1991, R. Donangelo from Rio de Janeiro came to work on nuclear physics.

Nordita's links with Uruguay were not that extensive and the only visit was by N. J. Azziz in May 1967, at that time associated with the Atomic Power Division of the Westinghouse Electric Corporation, Pittsburgh. However, Nordita staff considered Azziz more a member of Westinghouse than of the University of Montevideo.[5]

The most important long term link between Nordita and a scientist from the River Plate is with Daniel Bes, a researcher known in Argentina for his association with the Tandem Laboratory of the National Commission for Atomic Energy. Bes had been associated with the Argentinian National Directorate for Atomic Energy since the early 1950's. In 1953 he began to work with a Philips cascade accelerator of the type Cockcroft-Walton in Buenos Aires. Bes joined the team which worked at the mass spectroscopy laboratory and soon later with the group which assembled spectroscops. These equipments had come attached to Peron's ill fated atomic adventure at Huemul island. As Peron's program collapsed, well prepared Argentinian physicists constructed a high quality training program. A summer school of physics was created in 1954 in which Bes, participated in the course in quantum electrodynamics. At the Second Summer School of Physics, 1955, it was decided to create an Atomic Center and a Physics Institute (Mariscotti, 1985: 258—264). The Bariloche institutions, despite the tragical political fluctuations of Argentina, are still among the best in Latin America.

Bes, then formally at the Faculty of Natural and Exact Sciences of the University of Buenos Aires, was invited to come to Nordita by Don R. Mottelson and Aage Bohr.[6] As a result of his visits to Nordita in 1965, Bes published a number of papers on nuclear vibrations in international journals such as Physics Letters and Nuclear Physics. Bes became a constant visitor to Nordita from 1975 to 1992. He also lectured in Helsinki, at the University of Lund and at the Stockholm's Institute of Atomic Physics.

Another visitor to Nordita with an Argentinian background is Leo Falicov. His work on solid state physics is well known in the physics literature. He has also contributed to the training and advancement of important Brazilian physicists. In 1972 Falicov, Cylon E. T. Goncalves da Silva, a graduate from Porto Alegre, and B. A. Huberman published a Nordita paper on "metal-insulator and magnetic phase transition" (Falicov, Goncalves da Silva, and Huberman, 1972). Although Falicov belongs much more to Berkeley than to any Latin American Institute, he has played a significant role in establishing links between Latin American Institutes

and major centers of physics in the world. Huberman, associated to the Xerox Research Center at Palo Alto, California, and Sonia Solla, from the AT&T Bell Laboratories at New Jersey, are also Argentinian visitors to Nordita.

The Iberian Relations

Since 1979, there has been a growing interaction with the Iberian Peninsula.

Solid state physicist F. Garcia-Moliner from the Universidad Autonoma de Madrid visited Chalmers Technical University, the University of Oslo and Nordita in June 1979. The application for funds to invite Garcia-Moliner is particularly interesting because it contains an open and direct statement on Spanish political conditions. Garcia-Moliner had built a research group of international recognition-"a center of excellence"-despite the Spanish "difficult political climate."[7]

Since then interactions have accelerated, including with Portugal. In 1983, R. Dilao and A. Noronha da Costa came from Lisbon to participate in the Chaos workshop. In 1986, J. M. Carmelo worked with Allan Luther in solid state physics. In 1991, L. Ferreira from Lisbon and J. Pacheco from Coimbra came to work in nuclear physics.

The interaction with Spain benefited greatly from the establishment of the European Astronomic Observatory Roque de los Muchachos at La Palma, Tenerife, Canary Islands in 1985. Created in the early 1970's, the Observatory is housed in the Instituto de Astrofisica de Canarias, at Tenerife (Rees, 1992). Given that astrophysics is one of Nordita's areas of work, interaction with Tenerife and by extension with Spain is expected to increase, specially now that the Nordic countries have upgraded the two ton mirror, with 2.56 meters in diameter, Optical Telescope at La Palma, by installing active optics to compensate temperature, wind velocity changes and other deformations.

Central to this process is the work and network of astrophysicist Bernard Jones. In September 1983, Enrique Martinez Gonzalez arrived from Santander to work with him. In December 1980, V. Vento who was at Saclay in France came for a Nordita Symposium on QCD, Quarks and Bags, where he presented a paper on "an exact non-linear solution to chiral bags." He settled in Valencia and visited Nordita several times, participating, for instance, in the June 1989 Nordita Workshop on Chiral Bags. Other Valencia collaborators include Vicente Martinez Garcia and Y. Park. Valencia is the most visible recent node in the Nordita network.

Concluding Remarks

Nordita is certainly not the only Swedish institution involved in constructing networks with Latin and Ibero America. One example is the International Seminar at the Physics Institute in Uppsala. Another is the Swedish Institute, SI, which is an organization responsible of awarding fellowships both for Swedes to go abroad and for visits into Sweden. SI has built a considerable network over the years. Such networks are primarily knowledge networks which depend on individuals. Institutions link because individuals exchange ideas.

The cases here discussed demonstrate the existence of knowledge links between nodes in the periphery and nodes in the centre. At the end of the 18th century, Sweden was not at the center of the great developments in science and technology . But from the perspective of visitors from Latin and Ibero America, Sweden was a centre to be reckoned with. In certain knowledge areas — and areas of particular interest to the visitors — like mining and production of weapons, Sweden was not very far off from the rest of Europe. These visits demonstrate the potential of nodes in the periphery to illuminate developments in the central nodes.

Two hundred years later a Nordic institution, Nordita, was constructed on the basis of the concept of network. For Latin and Ibero American scientists, Nordita has represented the possibility of linking with other re-

searchers and their institutes in Sweden. Nordita's activities and selection mechanisms, favouring qualified scientists and institutes, resulted in the emergence of a global network with high quality nodes in the periphery. The case of Valencia is worth mentioning. Moreover, although not yet reaching the level of the best European centres, Porto Alegre in Southern Brazil became a regional center in Latin America. Thus, Nordita is a strategic node which has both legitimized and opened links for institutes in developing regions meeting its quality criteria.

In principle, the flow of ideas and people gave us six possibilities of interest. Ideas may flow in one direction only or in both. The same is true of of people. There is also the possibility of ideas flowing without a corresponding flow of people. The reverse seems to be an almost impossibility although we could conceive the situation where a scientist visits a place but, because of events such as the cold war, does not exchange ideas in his knowledge field. But one would expect this scientist, for the same reasons, to report back on his trip.

That ideas will flow from the center to the periphery is to be expected if a node in the periphery claims to be in the network. Researchers in the periphery use, want to use, or claim to use, ideas produced at the center. This is, in many ways, the trivial case. A look at the Swedish articles cited by Spanish researchers, for instance, would provide us information on this type of linkage. Rarer is the case when the knowledge flows from the periphery to the centre, without the flow of people. As a node in the periphery moves towards the center, the intensity of the flow of ideas should increase. A network is of the first kind when ideas flow without the flow of people.

In a network of the second kind researchers flow in addition to the flow of ideas, but such a flow occurs not in an exchange basis. The usual situation is when researchers flow from the center to the periphery. Once a physical contact is established, it is hard to believe that ideas will not flow in both directions. The Linnean Löfling and his visit to Venezuela contributed to the exchange of ideas between Mutis and Linnaeus. The visit of Bonifacio to Scandinavia resulted not only in a collection of specimens in a Brazilian museum but also in research papers published in international journals on the minerals. Such is also the case, so far, of the relationship between Nordita and Brazilian institutes of physics like Porto Alegre. Ideas flow both ways. Nevertheless, the Eugenie expedition illustrates that visitors may come and go as observers and reporters, contributing nothing to the local development.

In the network of the third kind there is a flow of people back and forth between the nodes in the center and in the periphery. Institutions are most likely involved. By linking with struggling institutions in the peripheral nodes, those at the center may provide not only a life line, but also a pathway which the node will travel to the center or very near it. This was the case of Nordita and physics in Spain.

The case of Nordita reveals some of the necessary elements of the movement of a node from the center to the periphery. If an institution does not exist, there is a need for an institution builder, as Jacob in Porto Alegre or Vento in Valencia. The quality of the work has to be good enough to allow for ideas to flow past the selection gates. The research area in the peripheral node has to coincide with that in the central node. Moreover, external barriers have to be low enough to allow for the flow, although the contacts between nodes may have occurred while the political and economic barriers were high.

The trivial case is always to be expected if a node in the periphery wants to establish a link with a node in the center. The issue becomes how to move from being a network of the first order and first kind to become a network of the third order and the third kind. One path may be to send a researcher from the periphery to the center. The researcher has to be accepted and this may well depend on personal knowledge, that is on personal networks, in addition to work quality.

The lack of conditions for institutional de-

velopment may result in a network of the second kind. The difference between a network of the first and the third kind has, most likely, to do with the availability of material resources. This in turn may be a result of political and social priorities. The democratization process in Spain removed political barriers. This was also true in Latin America. Nevertheless, the economic barrier is still an important issue. Political changes are not enough in the absence of economic resources. But both are irrelevant if there is not a compatibility of research fields between the center and the periphery and meaningless if the local culture in the periphery does not support those with the will to research at a quality level acceptable by those in the central nodes.

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NOTES

1. Nordita was not set-up "on the same day" as the CERN Theoretical Group moved to Geneva, as it is written in History of CERN (Hermann et al. 1987, I: 416).
2. See for instance the notes to one of the courses in the previous Latin-American School of Physics (Steffen, 1961). The notes were prepared by Victoria Hercovitz, Maria Luisa Ligatto and Carlos Lopez Silva. Hercovitz was from Porto Alegre and a few years later became one of the leaders of its physics institute. For later Mexican relations with Nordita see Sondegaard, Inge (Secretary, Nordita) to Prof. L. Carrasco, Heidelberg, Germany, 22 Sept. 1980; Martison, Indrek (Physics Institute, University of Lund) with Torkild Andersen (University of Aarhus), Osvaldo Goscinski (University of Uppsala), Sven Mannervik (AFI, Stockholm). "Application to Nordita to invite C. F. Bunge," 30 January 1982. Martison, Indrek (University of Lund). "Multipelt exciterade atomer — teori och experiment," Ansökan till Nordiska Komitten för Acceleratorbaserad Forskning, n.d. All letters and documents are from Nordita's files in Copenhagen, Denmark.
3. Tyren, Helge (Gustaf Werner Institute for Nuclear Chemistry, University of Uppsala) to Brown, Gerhard (Nordita), 10 March 1961.
4. Salmeron, R. A. (CERN, Geneva) to Rosenfeld, L (Institute for Theoretical Physics, Copenhagen) 16 Sept. 1958.
5. Brown, G. E. to Azziz, Nestor (Westinghouse in Pittsburgh) 8 March 1967.
6. Mottelson, Don R (Nordita) to Bes, Daniel (Faculty of Natural and Exact Sciences of the University of Buenos Aires) 10 April 1964.
7. Lundqvist, Stig (Department for Theoretical Physics and Mechanics, Technical University of Chalmers and University of Göteborg) to Nordita, 27 February 1979; Hedin, Lars (Deparment of Theoretical Physics. University of Lund) to Robert Nilsson (Nordita) 2 March 1979.

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