2018 NATURAL AND EXACT SCIENCES NUCLEI COMPETITION

Recommendations of the Program Committee in Natural and Exact Sciences

Taking into consideration the grades of the New and Renewal Proposals submitted to the **2017 Natural and Exact Sciences Institutes Competition**, as well as the results of the in-person interviews carried out between **March 5th and March 8th 2018**, the Millennium Science Initiative Program Committee recommends to the Advisory Board the following ranking for the awarding of both types of proposals:

1) RANKING OF THE PROJECTS RECOMMENDED TO BE AWARDED ACCORDING TO THEIR MERITS

1. **Millennium Nucleus for Metal Tracing Along Subduction; Principal Investigator: Reich**

   This nucleus proposes a multi-disciplinary approach to address a fundamental problem in geology: How do metals concentrate and form large ore deposits in the crust?
   To address this question, the team proposes to closely look at crust-mantle interactions in a subduction zone (mostly indirectly by state of the art geochemical means) and investigate near-surface processes (hydrological cycle) in detail. Such a holistic approach might lead to a deeper understanding of ore accumulation processes.

   From the written renewal proposal, as well as from the oral presentation, it became clear that the nucleus has amply fulfilled the committee's expectations. They have consolidated their group as a center of frontier research in ore deposits, a topic of vital importance for Chile's mining industry and economy. In this context, their scientific results will help to provide a scientific basis for the optimization of mining strategies and ore processing technologies. One of the long-term goals of this group is to become a leading center in ore studies in the southern hemisphere. After reading the list of achievements, the committee is confident that this group is on the right track to attain this aim. By combining geochemical, isotopic, and petrological methodologies, field studies, and state of the art laboratory analyses, this group has successfully created a synergetic environment that is highly productive, both in teaching and in publishing in high profile journals.

   In the renewal proposal, a new research line focusing on volatiles in volcanic arc magmas has been integrated and will add a new and interesting complementary topic that promises to yield fruitful results.

   In short, considering the large number of achievements, the still young age of the PI and some of the associates, extent and quality of the team's research network, the innovative planned approach to new and interesting questions to be solved in the future, the relevance of the topic for Chile's economy, the MSI scientific committee found unanimously that this proposal is outstanding and strongly recommends funding for the next three years. This team has international stature and has the

capacity to reach the proposed goals, including becoming a center of international reference in regard to the study of ore deposits.

2. **Millennium Nucleus on Smart Soft Mechanical Metamaterials MN-S2M3; Principal Investigator: Palza**

The proposal deals with "Smart Soft Mechanical Metamaterials", its preparation, its use to create meta-materials and its further application in developing machines. The members of the team have been able to convincingly demonstrate how they are able by to employ elastomers and hydrogels whose properties can be improved by tuning the engineered structural properties, and by adding multifunctional nanoparticles to allow for the response to an external stimulus. The materials are formed into three-dimensional object by a 3d-printing process and investigated for their mechanical properties. The application towards machines with intelligent performance towards robotics holds potential towards the mimicking of living organisms. The panel was deeply impressed by the presentation of the scientific results the competence of the rather young members of the nucleus revealed in the discussion. The efforts presented towards fostering young researchers, as well the outreach activities have been equally impressive. The panel unanimously voted to fund the nucleus with the highest priority.

3. **Millennium Nucleus Paleoclimate; Principal Investigator: Moreno**

This multi-disciplinary team is young and of international stature. It will take advantage of high-resolution sediment records in lakes and bogs of Patagonia, together with glacial deposits and volcanic ash markers, to study multiple sensors of past climatic change. Data obtained from these terrestrial proxy records will be utilized via numerical models to explore the mechanisms underlying paleoclimate phenomena. Special attention will be given to the last glacial-interglacial cycle because deposits of that age are ubiquitous and well preserved in the geologic record, providing a time frame for understanding processes and impacts of climate variability and trends most relevant to the recent past. Results will shed light on future climate scenarios and their possible impact on society. The subject of paleoclimate is of particular relevance in the context of present climate changes. Studies of this type have been mostly carried out in regions of the northen hemisphere, hence the present proposal attempts to fill an important gap of knowledge.

In short, this proposal brings together highly qualified individuals, all embedded in a large international network, that have the capacity to carry out a project for which Chile (Patagonia) has unique geographic advantages and that will contribute important data required to better understand Quaternary paleoclimate changes on a global scale. The methodologies described, although not particularly novel, represent state of the art procedures. Previous experiences and collaborations among members of this nucleus have produced great results. Consequently, the committee strongly recommends funding the present proposal.

4. **Millennium Nucleus in Cardiovascular Magnetic Resonance; Principal Investigator: Uribe**

Improving the diagnosis of cardiovascular diseases is a topic of great relevance for public health. This proposal will develop new methods to analyze cardiac magnetic resonance images (MRI). One of its main strengths and originality is to be genuinely multidisciplinary. The expertise of biomedical engineers, medical doctors and mathematicians have been put together to propose a very ambitious and innovative research program. This unique group has the capability to propose new tools and to design new biomarkers for the early diagnosis of cardiovascular diseases like atherosclerosis and cardiac failure. The methodological side is very strong, with excellent expertise in MRI and in recent and promising mathematical techniques like compressed sensing. Preclinical and clinical studies will ensure that the theoretical findings will be of practical interest. The training plan is well-thought and the international network of the consortium is very good. The oral presentation and subsequent interview by the committee members were very convincing. As a consequence, the Program Committee recommends that the proposal be funded.

5. **Millennium Nucleus on Catalytic Processes Toward Sustainable Chemistry; Principal Investigator: Escalona**

The production of added-value chemicals and fuels from biomass using sustainable processes represents a major international endeavor. It is therefore of strategic value for Chile to be part of this effort. This Nucleus would be a unique centre in Chile for developing fundamental research in catalytic processes addressing biomass conversion and the production of fuels. Hydro-treatment and photo-catalysis reactions will be at the focus of their activities. The milestones were very clearly identified, likewise the interactions/collaborations between the team members. In addition, this highly qualified team has established a strong international network with highly qualified international partners. It will allow them to greatly benefit from their expertise and equipment.
The evaluation panel was very pleased with the approach followed to reach most relevant and challenging objectives, and unanimously considered this very strong proposal as deserving funding with very high priority. The applicants should also be congratulated for a good gender balance in the team that includes a female alternate director, an ambitious training plan, and the implementation of innovative outreach activities.

6. **Millennium Nucleus Center for the Discovery of Structures in Complex Data; Principal Investigator: Jara**

Developing new mathematical methods for data analysis is undoubtedly of strategic importance for any country. The originality of this project is to put an emphasis not only on big data but also on complex data. The associate researchers are excellent scientists, with remarkable publication records. The consortium has a good balance of young and senior researchers and enjoys very good international visibility, as shown by several honors and awards, and by the participation on several editorial boards of very good statistics journals. They propose to develop and evaluate properties of non-parametric methods, possibly in a Bayesian framework, to analyze data in three settings: data with dependence and non-Gaussian structure, time to event data, and time and space data. This is primarily a fundamental research program, but the new methods and algorithms will be tested on real datasets, which

are already available and come from different relevant sources: HIV infection in Chilean population, data from the biomedical imaging center at University of Chile, El Niño Southern Oscillation, Education Quality Measurement System. Besides the research aspects, the proposed outreach and training activities are also very convincing. As a consequence, the Program Committee recommends that the proposal be funded.

7. Millennium Nucleus Biology of Intestinal Microbiota; Principal Investigator: Paredes

This is an outstanding proposal by a group of accomplished young investigators to conduct studies on the intestinal microbiota. It is well established that complex bacterial communities populate all surfaces of the human body, including the skin and the mucosal surfaces that line the intestinal and respiratory tracts. In fact, it has been estimated that the human body carries more bacterial cells that the cells that make up all the body tissues combined. One of the most exciting developments in the field of biomedical sciences during the last decade is the realization that those bacteria are not passive companions but play a fundamental role both in normal body physiology as well as in numerous pathological conditions. Thus the study of the human microbiome, and in particular the intestinal microbiota, is one of the most exciting areas of biomedical research today. Despite its central importance, however, knowledge of the mechanisms by which these complex bacterial communities exert their beneficial or pathological effects, or even the mechanisms by which they colonize and persist within the host, is scant and limited to a few bacterial species that are genetically tractable. Paredes and collaborators proposed a bold and incisive research program aimed at characterizing a family of bacterial species, which despite their quantitative importance in the gut microbiome, have not been studied. In particular, Paredes et al proposed a well articulated research program aimed at understanding the mechanisms by which members of the Ruminococcaceae family of bacteria colonize and persist in the gut. The research team cleverly leverages their expertise in handling and manipulating these poorly studied bacteria, which positions them very favorably to compete in the international arena. The proposed nucleus will address a fundamental deficiency in Chilean science, will help foster microbiome research in Chile and Latin America, and will train students and postdocs in this important and specialized area of research. Consequently, the panel was unanimous in considering this proposal worthy of funding.

8. Millennium Nucleus on Interdisciplinary Approach to Antimicrobial Resistance; Principal Investigator: Munita

This is an outstanding proposal to investigate various aspects of antimicrobial resistance. One of the most challenging global public health problems today is the emergence and spread of microorganisms that are virtually resistant to all the available antibiotics. A compounding issue is that the pharmaceutical industry is abandoning antibiotic research to focus their efforts in the development of more profitable drugs. Consequently, it is imperative to make judicious use of the currently available drugs. Central to this aim is the understanding of the mechanisms by which antibiotic resistant microorganisms emerge and persist in the environment, how they spread from the community to the hospital setting and back, as well as the potential role of food producing animals in the emergence of antibiotic resistance genes.

Munita and collaborators have assembled a multidisciplinary team to address these fundamental questions. More specifically, they proposed a series of sophisticated epidemiological studies that will leverage a unique resource, the Mauco cohort, which will enable them to probe fundamental questions about antimicrobial resistance emergence, persistence, and spread. The nucleus has set realistic goals that could result in the acquisition of fundamental knowledge that could guide important Public Health Policy decisions. The team is very well qualified to carry out the proposed studies. However, as acknowledged by the P. I., to maximize the output from these studies, the team will need to seek out assistance from qualified statisticians and mathematicians to provide help in the analysis of the plethora of data that will emerge from these studies. However, the committee is confident that such assistance will be available, and that the proposed studies will have great local and international impact. Consequently, the committee was unanimous in enthusiastically recommending this proposal for funding.

9. **Millennium Nucleus Center for the analysis of partial differential equations (CAPDE); Principal Investigator: Quaas**

The analysis of nonlinear partial differential equations is a fundamental topic in mathematics, and has a major role in the modeling of many phenomena in natural sciences, economy and engineering. The previous Nucleus was extremely successful in terms of publications and training, both qualitatively and quantitatively, and in terms of networking. In addition to its research results, the group should be commended for its outstanding outreach activities. The directors and associate researchers are first rank mathematicians, with strong international visibility in their respective domains. The group has attracted a new member who is a young, bright expert in nonlinear dispersive equations. The team has complementary expertise and covers a vast range of equations. Even if a broader opening to other disciplines and applications would have been appreciated, it is clear that fundamental advances in the theory of nonlinear partial differential equations will result from the proposal. The Program Committee therefore recommends that the Nucleus be renewed.

10. **Millennium Nucleus in glacial water resources and hazards; Principal Investigator: Casassa**

This nucleus aims to predict the response of glaciers to climate change and determine possible consequences for water resources and hazards, thereby establishing, a direct link to future environmental and social developments. In doing so, this team proposes a multi-disciplinary approach that ranges from glaciology, hydrology, climatology, and meteorology, to geochemistry and biology. Eight sites in different hydrological basins have been selected, where field data (installation of weather stations, geodetic baselines, ice-thickness measurements, chemical analyses of snow, lakes, etc.) will be collected and combined with remote sensing data. With the obtained data, numerical modeling will be undertaken to establish trends and obtain predictions that could be useful in characterizing the magnitude of possible future hazards (e.g. catastrophic floods or shortages of water for agricultural and domestic use). Needless to say, it is mandatory to know more about this subject in order to make the necessary adjustments and be in a position of minimizing the adverse effects of future climate change. Although the proposed

project focuses on the southern Andes, results and methods will be instructive for other mountainous areas of the world.
This relatively large group of multidisciplinary researchers seems to be able to conduct the proposed work and stand out at the international level as a result of their personal achievements and broad range of disciplines covered in the project. The scientists are from different institutions, including several outside the Santiago metropolitan area. The team is well-balanced in terms of experience, age, and gender, all of which are in compliance with current MSI policies.
Although the proposal is written in a convincing and succinct fashion, during the oral presentation it became clear that a relatively low number of 2 postdocs, 2 graduate students and 2 undergraduates would be funded per year.
Nonetheless, the scientific committee considers that this project should be funded.

11. **Millennium Nucleus Algorithms for Contemporary Challenges in Society; Principal Investigator: Wiese**

The importance of algorithms in our daily life is obvious to anyone who uses a smartphone. The proposal addresses this major topic along three mains directions: efficiency, learning and game theory. This covers a wide range of very active and timely research fields: basic science in algorithms (scheduling, packing, matching), machine learning methods with a special interest in differential privacy, dynamics of agents competing for limited resources, etc.
The proposal gathers a group of young and promising mathematicians and computer scientists who have excellent publication records and an excellent network of collaborators, in particular with the Game Theory group in Paris, and with the Max-Planck Institute for Informatics. While the scientific quality of the group is excellent, the oral presentation could have be more specific to clearly articulate the research program. The written proposal fortunately compensated for this lack of detail. This is overall a basic science project, but the group has also worked on very relevant real-life applications, in particular for fare evasion in transportation networks and for school admissions procedures. This makes the committee confident that the theoretical findings of the project can have a real impact on Chilean society. The proposal also contains an excellent group of outreach activities, in particular towards high school students and teachers. For all these reasons, the Program Committee recommends that the proposal be funded.

2) PROJECTS NOT TO BE AWARDED (RESERVE LIST)

12. **Millennium Nucleus in Epigenomics; Principal Investigator: Silva**

This is a strong proposal to investigate the epigenomic landscape of sweet cherry stone during fruit development. Epigenomic changes are essential to coordinate fruit development and, importantly, these changes ultimately represent the interaction of the genes with the environment. Changes in the environment driven by global climate change are affecting agriculture activities. To understand the impact of those changes it is important to determine the epigenomic landscape of important crops such as sweet cherry. Although the epigenomic landscape of model plant species is reasonably well understood, little to no information is available on members of the rosacea family of plants, which includes several species of great agricultural importance, such as sweet cherry. Silva and collaborators prosed a series of highly

collaborators prosed a series of highly focused studies to fill this knowledge gap and map the epigenomic landscape of sweet cherry, leveraging state of the art technologies. There is strong confidence that the research team will be able to accomplish the realistic goals that they have set out. Furthermore, there is strong support for the proposed studies. However, the review panel would have liked to see a more developed plan for how the information to be gathered through these systems biology studies will be leveraged to better understand plant development. Nevertheless, the committee felt that the information to be obtained through these studies is of great importance as it will be necessary in the future to guide plant breeding programs that may have to be established to better adjust to the changing agricultural landscape due to climate change and other environmental challenges.

13. **Millennium Nucleus Interdisciplinary Center for Astro-Particle Physics (i-CtA); Principal Investigator: Reisenegger**

In addition to already hosting many of the world's most powerful optical and radio telescopes, Chile will play host to the bulk of the Cherenkov Telescope Array (CTA) from the early-2020s. The CTA will revolutionise gamma-ray astronomy, much as ALMA in Chile has done for sub-millimetre astronomy. This proposal seeks to ensure Chilean scientists are well-positioned to capitalise on the 10% of observing time with CTA guaranteed for Chilean astronomers. It does this by bringing together experts in astrophysics, particle physics, software, and science education from 5 universities. There is a window of opportunity for Chile to play a key role in software for array control, as well as in managing dataflow. The approach of going beyond the usual Outreach activities into development and evaluation of a STEM education program is particularly innovative.

While the Program Committee recognizes that one of the Nucleus goals is to help develop such expertise, the current dearth of "hands-on" experience in gamma-ray astronomy using precursor facilities such as HESS and VERITAS among the Directors and Associate Researchers was a concern. Combined with the limited amount of expertise available for the proposed machine learning and data processing activities, the Committee felt it premature to recommend this Nucleus for funding in the current round.

14. **Millennium Nucleus in Paleobiology of Earth-Life Transitions (PELT); Principal Investigator: Rivadeneira**

This paleoecological project is led by a productive multidisciplinary team from a diversity of institutions inside and outside of the Santiago Metropolitan Area. The proposed research addresses critical issues concerning the relative importance of climatic and anthropogenic factors in affecting the tempo and mode of biotic change during three environmental transition periods in earth's history. Moreover, its focus on the Humboldt Current Large Marine Ecosystem is important, as this area represents one of the most productive marine ecosystems in the world. Nonetheless, it was not sufficiently clear from a methodological perspective, how anthropogenic effects could be decoupled from those of non-anthropogenic origin. Similarly, the committee was concerned that the complexities of unraveling the fossil record to a sufficient level of taxonomic, spatial, and temporal resolution

Taken together, these considerations lead to the recommendation by the committee that the project was worthy of funding, but that it was not as much of a priority to do so compared to other outstanding projects.

15. Millennium Nucleus for the Study of Pain (MiNuSPain); Principal Investigator: Calvo

The millennium "Nucleus Center for the Study of Pain (MiNuSPain)" would be dedicated to fundamental basic neuroscience studies of the intracellular signaling underlying the development of neuropathic pain. The importance of the subject was clear to all the members of the committee, and the clear experimental plan and experimental approach were strengths of the proposal. However, the narrow focus of the studies on particular signaling pathways could also be seen as somewhat of a weakness. While the group members have different expertise in the molecular and cellular neuroscience realm, the group is relatively cohesive in its methodologies in this area. Chronic pain is a highly studied area of basic science, and there are many groups around the world studying intracellular signaling in this area. The likelihood that any single set of molecular targets will lead to a fundamental breakthrough in understanding chronic pain or pain treatment is therefore difficult to assess. As a result, it is not clear how MiNuSPain will define themselves as unique within this highly competitive international scientific space. A strength of the proposal was the immediate possibility to translate the molecular findings of the group to the clinic, but here the lack of well developed statistical models to evaluate the outcomes of the clinical trial work was considered to be a weakness. Similarly, lack of broad experience in the clinical trial realm raised some concerns.

16. Millennium Nucleus Biology of Neuropsychiatric disorders- NuMIND; Principal Investigator: Chávez

This is a proposal for continuous support for a nucleus that brings together a group of highly accomplished investigators to carry out studies on the biology of neuropsychiatric disorders, an area of research under intense scrutiny around the world. The overall goal of this proposal is the study of synaptic function in the hippocampus, prefrontal cortex, amygdala and striatum. The group plans to leverage existing animal models to examine how these fundamental processes are altered during psychiatric illness. The strong preliminary data provides support for the experimental systems to be deployed in these studies. The review panel considered the research team very well qualified to carry out these studies as demonstrated by their published work. However, while the public health importance of the studies is obvious, the potential international impact of the proposed studies is less clear. Indeed, this specific area of research is under heavy scrutiny around the world at research centers that may be able to deploy more resources. The research team did not adequate articulate what specific aspect of their research program will allow them to position the nucleus in a manner that would allow them to successfully compete is not the international arena. Consequently, although the competency of the investigators is not questioned, the potential for impactful research was considered uncertain. Consequently, this proposal was not considered worthy of funding.

3) PROJECTS NOT GRANTED

17. **Millennium Nucleus Interdisciplinary Center for Green Chemistry: CEQUIV; Principal Investigator: Contreras**

Green chemistry has become a central field in academia and industry because of the environmental constraints and the need to make use of renewable resources with maximum efficiency and minimum waste. In this proposal, 6 laboratories are involved to cover a wide range of activities, from chemical synthesis, extraction and micro-extraction methods for analytical applications and processes, green materials for energy applications, deep eutectic solvents for medical and biomedical applications. Although some members of the team have great expertise in areas relevant to the previous and highly successful nucleus they were running on ionic liquids, it was not clear to the evaluation panel how the collaboration between the team members would be implemented to address specific objectives. This was not facilitated by a presentation in successive "teams" rather than in common objectives. In some instances, the targets selected were not convincing from the point of view of their originality in an international perspective. Although the evaluation panel appreciates the effort dedicated to the interactions between "Green Chemistry and Society", it could not recommend this Nucleus for funding in view of the high number of outstanding proposals present in this competition.

18. **Millennium Nucleus: Corrosion Science and Protection of Materials; Principal Investigator: Páez**

The creation of a Corrosion Science & Protection Nucleus aiming at generating better fundamental knowledge and understanding of corrosion phenomena is certainly a most valuable objective in view of the major scientific, technological and economic relevance of this topic. The study of corrosion science and materials protection offers an opportunity for multidisciplinary approaches, ranging from surface science and engineering, the use of innovative surface treatments for metal alloys, polymeric coatings to the study of the biophysical, biochemical, electrochemical and chemical behavior of the interfaces. All these aspects have been addressed to various extents and grouped under the overarching theme of "Green anticorrosive processes". Despite the fact that the composition of the highly qualified and active team reflects the diversity of competences needed, a clearer prioritization of the tasks and the implementation of more innovative approaches were considered by the evaluation panel to be necessary for this Nucleus to make a major impact at the international level. It could therefore not be recommended for funding in view of the number of outstanding proposals in this very severe competition.

19. **Millennium Nucleus for Light-Matter Interactions in Nanomaterials; Principal Investigator: Muñoz**

This proposal deals with the study of electronic properties of 2D-materials (graphene, h-BN), topological insulators and their heterostructures, focusing in particular on their interaction with light. By combining synthesis, characterization and modeling studies, 2D topological materials and heterostructures should be produced. The overall

objective is to contribute to the design of new optical nanodevices to manipulate, store and transfer information. The focus is placed on electro-optical interaction between single light emitters, and individual and collective excitations in heterostructures. The topic is both timely and relevant, but international competition is fierce. Despite the quality of the team and their complementary expertise, the evaluation panel considered that this team was not currently in a position to impact the field in a unique way that would be internationally competitive. At the same time, the panel would encourage this young and dynamic team to find other funding mechanisms allowing them to develop a unique research line in Chile and train young scientists in these important topics.

20. Millennium Nucleus on Laboratory Solid-state astrophysics; Principal Investigator: Cieza

This Nucleus proposal has an overarching goal to understand the formation of the Earth. It would do this by combining the efforts of 3 separate laboratories to study the opacity of interstellar dust, coagulation of dust particles, and meteorites collected in Chile. Remarkably our ability to interpret ALMA images of protoplanetary disks around stars (such as those obtained by the earlier Millennium ALMA Disk Nucleus) is hampered by simplistic conversions from dust opacity to dust mass. This Nucleus seeks to rectify this situation by using meteorites as "truth samples" of interstellar dust for measuring their opacities under conditions like those experienced in protoplanetary disks, as well as conduct pioneering experiments in granular physics to understand how dust grains in disks come together to ultimately form planets.

While the Program Committee was sympathetic to the cost of running such laboratories, and the goal of establishing a laboratory in Chile to preserve, process, and analyze meteorites collected from Chile, it was not convinced that Chilean meteorites are sufficiently special to make this an essential aspect of the proposal. Furthermore there were concerns about the petrology, including whether meteorites are good analogs for circumstellar dust given the influence of violent events in our solar system in general, and the formation of the Earth and Moon in particular. Given the intense competition in this Millennium Nucleus round the Program Committee was unable to recommend this proposal for funding.

21. Millennium Nucleus of Developmental Tissue Mechanics; Principal Investigator: Concha

The primary strength of the Millennium Nucleus of Developmental Tissue Mechanics is the scientific rigor and achievement of the experimental team and their track record of carrying out interesting cell biological studies. This new nucleus is focused on a bold shared concept that development of tissues is guided by tensile forces that guide cell fate and specialization. However, beyond proposing some novel tools to measure these forces in vivo, the program of the Nucleus was quite vague and the ability to go beyond descriptive studies was not well articulated. Despite the interesting combination of three model systems, it was also not clear how the team would form an internationally-competitive team devoted to developmental biology, given the intense competition in this area and the rapid pace of technological advance. The inability to articulate specific goals that would define success after three years made it difficult to evaluate whether the proposal could achieve its

ambitions. As a result of these concerns, the committee could not recommend funding of this proposal.

22. Millennium Nucleus for Study and Conservation of Deep Reef Ecosystems; Principal Investigator: Perez

The paucity of ecological understanding about deep reef ecosystems--those extending between depths of 30 m and the continental shelf--motivate this transdisciplinary research project. The collaborating team of six investigators from three institutions, both inside and outside of the Santiago Metropolitan Area, has been productive in scholarship as well as in the education and training of students. The research project is quite complex, addressing eight objectives related to four interrelated themes: (1) Deep reef biodiversity; (2) Disturbance; (3) Connectivity and refugia; and (4) Trophic dynamics and resilience. The consensus of the committee was that the project was overly ambitious and too broad for a nucleus to address with a high likelihood of success. Moreover, the committee was concerned that logistical issues concerning the coordination of field activities might compromise the success of a project that is driven by the gathering of diverse data from a variety of sources. Similarly, the spatial specificity of sampling was not clearly exposed in the proposal. Finally, the plan for promotion of young scientists was superficial and not particularly innovative. Taken together, these considerations lead to the recommendation by the committee that the project should not be recommended for funding, especially given the highly competitive nature of the applicant pool.

23. Millennium Nucleus on Emerging Pathogens, Infections and Climate Change (EPICC); Principal Investigator: Medina

This project comprises a transdisciplinary team of scientists from a number of institutions, both inside and outside of the Santiago Metropolitan Area, who study the emergence and spread of viral pathogens associated with zoonotic diseases of human health concern (Hanta Virus and Influenza). In general, the scholarly productivity of and engagement in training by the five collaborating investigators is good but not excellent. Nonetheless, the plans for education, workforce development, outreach, and networking were very good. Unfortunately, the scope of the research was too broad. Its framework considers interactions among three thematic areas: (1) Molecular epidemiology and genomics; (2) Host-pathogen interactions; and (3) Ecology and climate change. The consensus was that a more focused and intensified exploration of one or two of the stated themes would have had a higher likelihood of success. Indeed, the breadth of the project's research resulted in each theme being characterized by insufficient detail to allow a confident assessment of its scientific rigor. Taken together, these considerations lead to the recommendation by the committee that the project should not be recommended for funding, especially given the highly competitive nature of the applicant pool.

24. Millennium Nucleus on Population Dynamics, Global Change, and Political Instability; Principal Investigator: Lima

This transdisciplinary project spans a suite of issues in the biophysical and social sciences, and includes a group of productive scientists in terms of scholarship, as well as in terms of the education and training of students. The project marshals three

broad modeling approaches to form a synthetic framework for understanding demographic trajectories in three groups of indigenous peoples in Chile. Nonetheless, the mechanics of integrating those approaches, or distinguishing their respective predictions, were not sufficiently delineated in the project to suggest a high likelihood of success. Moreover, the details of how social, anthropological, and archeological data would be combined to characterize societal "collapse" were vague, as were the approaches for characterizing relevant climatological data at the spatiotemporal scales relevant to each population of indigenous peoples. Finally, the education, training, outreach, and networking aspects of the project were solid but not outstanding. Taken together, these considerations lead to the recommendation by the committee that the project should not be recommended for funding, especially given the highly competitive nature of the applicant pool.

25. Millennium Nucleus on Physics of Complex Media; Principal Investigator: Melo

The project deals with two major research lines: one particularly on mining and natural processes via the investigation of the rheological properties of granular matter, and the second one to elucidate the physics underpinning catastrophic behavior of complex media. The proposal also included efforts on locomotion in complex media towards the creation of robots. Although the group members have excellent track records in the respective subareas, and the topic has the potential to be very important within Chile, the presentation as well as the following detailed discussion on the existing and planned experimental approaches, for example via instrumented particles for sensing and others, did not convince the panel fully. Also, the lack of appreciation of efforts elsewhere towards understanding geological phenomena relevant to the proposal was not helpful. Due to those deficiencies, the panel came to the unanimous conclusion not to recommend the nucleus for funding.

26. Millennium Nucleus Interdisciplinary Centre for Developmental Neuroscience; Principal Investigator: Peña

The Interdisciplinary Center for Developmental Neuroscience proposes a bold and novel hypothesis that neural entrainment, the oscillatory activity of the brain that aligns with periodic changes of learned stimuli, underlies the development of language in human children. While evidence supporting this hypothesis could provide novel directions for developmental cognitive neuroscience, the studies proposed are extremely ambitious, and many of the essential preliminary data, as well as some of the technologies, to achieve these ambitious studies are not yet in place. There are a large number of different experiments proposed, and there are varying levels of support for each set of studies. This perception is reinforced by the lack of details given in the research plan. For example, novel software to induce neural entrainment in young children that would allow the researchers to determine whether entrainment improves reading comprehension is not yet at an advanced stage of development, and the variables necessary to maintain engagement in young children may take a long time to establish. Similarly, the interesting studies on how neural entrainment relates to speech self-monitoring are at a very preliminary stage and have not yet been fully conceptualized. Essential details of how EEG classifiers would be developed were not in the written proposal, and the oral presentation acknowledged that issues of power would still have to be worked out before feasibility could be fully determined. While the multi-disciplinarity of the

proposal, and connections to foreign institutions and educational program are strengths, this also contributes to the unrealistically broad scope.

Final Grade Evaluation Criteria for New and Renewal Proposals

NEW PROPOSALS	%
Written Proposal Grade	50%
Scientific, technical and methodological merit. Clarity and forcefulness of the presentation as well as spoken defense of the proposal will be evaluated, considering the following: - Evaluation of the proposal in regards to the rest of the proposals competing for funding. - Degree of multi and transdisciplinary approach of the proposal. - Focus of the proposal placed in areas relevant to the country and the world, that address a problem where our country has a comparative advantage in terms of scientific research, or that provide some other type of contribution to the society. - Research proposal that differs from those currently covered by the Millennium Centers that are active at the time of application. - Level, solidity as well as organizational and integrated management skills of the group of Associate Researchers. - For Directors and/or Alternate Directors who have held this role in the past, the following will be evaluated: percentage of budget execution and refunding, timely compliance with the delivery of follow-up reports and compliance with the diffusion and implementation of PME.	50%
FINAL GRADE (weighted average)	**100%**

RENEWAL PROPOSALS	%
Written Proposal Grade	50%
Scientific, technical and methodological merit. Clarity and forcefulness of the presentation as well as spoken defense of the proposal will be evaluated, considering the following: - Previous accomplishments of the Institute - Evaluation of the proposal in regards to the rest of the proposals competing for funding. - Degree of multi and transdisciplinary approach of the proposal. - Focus of the proposal placed in areas relevant to the country and the world, that address a problem where our country has a comparative advantage in terms of scientific research, or that provide some other type of contribution to society. - Research proposal that differs from those currently covered by Millennium Centers that are active at the time of application. - Level, solidity as well as organizational and integrated management skills of the group of Associate Researchers. - Previous managerial performance of the Center: percentage of budget execution and refunding, timely compliance with the delivery of follow-up reports and compliance with the diffusion and implementation of outreach activities.	50%
FINAL GRADE (weighted average)	**100%**

Final Grades - Natural and Exact Sciences Nucleus Competition 2017 - Millennium Science Initiative

Ranking	Name of the Proposal	PI Last Name	Type	Written Proposal Grade 50%	Interview Grade 50%	Final Grade 100%	Status
1	Millennium Nucleus for Metal Tracing Along Subduction	Reich	Renewal	103	137	**120**	**Granted**
2	Millennium Nucleus on Smart Soft Mechanical Metamaterials MN-S2M3	Palza	New	200	100	**150**	**Granted**
3	Millennium Nucleus Paleoclimate	Moreno	New	129,2	172,8	**151**	**Granted**
4	Millennium Nucleus in Cardiovascular Magnetic Resonance	Uribe	New	111,8	192,2	**152**	**Granted**
5	Millennium Nucleus on Catalytic Processes toward Sustainable Chemistry	Escalona	New	143,3	176,7	**160**	**Granted**
6	Millennium Nucleus Center for the Discovery of Structures in Complex Data	Jara	New	163,1	158,9	**161**	**Granted**
7	Millennium Nucleus Biology of Intestinal Microbiota	Paredes	New	174,6	151,4	**163**	**Granted**
8	Millennium Nucleus on Interdisciplinary Approach to Antimicrobial Resistance	Munita	New	176,5	151,5	**164**	**Granted**

Ranking	Name of the Proposal	PI Last Name	Type	Written Proposal Grade 50%	Interview Grade 50%	Final Grade 100%	Status
9	Millennium Nucleus Center for the analysis of partial differential equations (CAPDE)	Quaas	Renewal	136,5	193,5	**165**	**Granted**
10	Millennium Nucleus in glacial water resources and hazards	Casassa	New	117,5	216,5	**167**	**Granted**
11	Millennium Nucleus Algorithms for Contemporary Challenges in Society	Wiese	New	111,8	226,2	**169**	**Granted**
12	Millennium Nucleus in Epigenomics	Silva	New	202	158	**180**	**Granted with no funding**
13	Millennium Nucleus Interdisciplinary Center for Astro-Particle Physics (i-CtA))	Reisenegger	New	180,3	181,7	**181**	**Granted with no funding**
14	Millennium Nucleus in Paleobiology of Earth-Life Transitions (PELT)	Rivadeneira	New	170,5	195,5	**183**	**Granted with no funding**
15	Millennium Nucleus for the Study of Pain (MiNuSPain)	Calvo	New	150,3	217,7	**184**	**Granted with no funding**
16	Millennium Nucleus Biology of Neuropsychiatric disorders- NuMIND	Chávez	Renewal	188,5	181,5	**185**	**Granted with no funding**
17	Millennium Nucleus Interdisciplinary Center for Green Chemistry : CEQUIV	Contreras	New	137,1	262,9	**200**	**Not Granted**

Ranking	Name of the Proposal	PI Last Name	Type	Written Proposal Grade 50%	Interview Grade 50%	Final Grade 100%	Status
18	Millennium Nucleus: Corrosion Science and Protection of Materials	Páez	New	137,8	264,2	**201**	**Not Granted**
19	Millennium Nucleus for Light-Matter Interactions in Nanomaterials	Munoz	New	147,3	258,7	**203**	**Not Granted**
20	Millennium Nucleus on Laboratory Solid-state astrophysics	Cieza	New	153,5	256,5	**205**	**Not Granted**
21	Millennium Nucleus of Developmental Tissue Mechanics	Concha	New	153,95	260,05	**207**	**Not Granted**
22	Millennium Nucleus for Study and Conservation of Deep Reef Ecosystems	Perez	New	161,5	254,5	**208**	**Not Granted**
23	Millennium Nucleus on Emerging Pathogens, Infections and Climate Change (EPICC)	Medina	New	163	255	**209**	**Not Granted**
24	Millennium Nucleus on Population Dynamics, Global Change, and Political Instability	Lima	New	172	248	**210**	**Not Granted**
25	Millennium Nucleus on Physics of Complex Media	Melo	New	175,1	246,9	**211**	**Not Granted**
26	Millennium Nucleus Interdisciplinary Centre for Developmental Neuroscience	Peña	New	179,7	246,3	**213**	**Not Granted**

The in-person interviews were developed in Santiago from Chile with the participation of all the members of the Program Committee in Natural and Exact Sciences. This document is signed by all members.

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Santiago, March 8th, 2018